ASTM BULLETIN

260 SOUTH BROAD STREET PHILADELPHIA, PA.

"Promotion of Knowledge of Materials of Engineering and Standardization of Specifications and Methods of Testing"

TELEPHONE—PENnypacker 3545 CABLE ADDRESS—TESTING

Number 89 December, 1937

A.S.T.M. Publications Used in Engineering Schools

Special Compilations and Symposiums Used in Numerous Courses

To those who participate actively in various phases of the work of Society, and to any member who reviews the official Year Book, it is evident that there is considerable interest in Society activities on the part of those connected with educational institutions, particularly, of course, technical and engineering schools. Two years ago there was published in the BULLETIN a list of schools which were represented in the Society membership—it is of interest to note that there were then some 111 schools in the United States and Canada who kept in touch with the Society either through departmental or library memberships, or through memberships of individual members of the faculty, the numbers in the latter case varying from one member to 16.

It is to be expected that engineering educators and their institutions would be concerned with Society work because of its activities in the field of engineering materials, both from the testing and research standpoint, from the standpoint of specification writing, and also because of the advancing knowledge of materials. At various times the attention of the members has been directed to the importance of a growing student membership. With no local chapters similar to those which many of the engineering and professional societies have, they are not offered quite the same social and fellowship advantages. Consequently, the some 360 student members of the Society can be considered to hold their membership largely because of their direct interest in A.S.T.M. work and also the receipt of its widely used publications.

STUDENT MEMBERSHIP PRIZE AWARDS

In passing, it would not be amiss to point out that the student membership prize award plan which has been in effect in a number of schools for several years has continued to keep the interest of A.S.T.M. before engineering students in certain schools. This plan provides for the award of student membership in the Society to certain students in various schools who have shown marked aptitude along various scholastic lines, the basis of the awards being stipulated by the A.S.T.M. member who underwrites the memberships and the dean of engineering or department head. In establishing these awards of student memberships, Society members are rendering important service in keeping the Society before various student bodies. The contacts made with winners of the awards have indicated a definite note of appreciation and because of the type of students who win the awards it can be expected that interest on their part will continue.

Any members of the Society who may wish to have further details of this student membership prize award plan should contact Society Headquarters. Full particulars will be furnished.

USE OF PUBLICATIONS

In line with the desire of the Society that its publications be used as widely as possible, and that maximum benefits be derived from its work, special prices are in effect to students on practically all of its publications. During the past few years the attention of department heads and other faculty members has been directed to this. It has resulted in a widespread use of a number of compilations of standards, symposiums, separate reprints and also the Book of Standards.

Referring specifically to the latter, there are five universities which make use of the Book of Standards, the students being able to secure the book at special reduced prices by virtue of holding student membership. Among the schools which have students obtaining the book in this way are Ohio State University, Pratt Institute, University of Delaware and College of the City of New York.

Contents

STANDARDS COMPILATIONS

In discussing the use of Society publications in schools, we should start with the compilation "Selected Standards for Students in Engineering." This was prepared several years ago under the direction of a special committee of educators who selected the standards. From its inception the book has found a definite place in the work of a number of engineering schools. During the period 1936-1937, for instance, there were some 40 schools who used the book, the orders aggregating about 1400 copies. A significant factor in the review is that quite a number of new schools have been added to the list of those procuring copies. This publication, 224 pages, including many of the more widely used tests and 17 specifications, can be purchased at 50 cents per copy in lots of ten or more, this price barely covering the cost to the Society.

While the use of other special compilations of standards has not been so extensive, their use in specific courses is interesting. For instance, the volume of Standards on Petroleum Products and Lubricants sponsored by Committee D-2 was used during 1936-1937 by some 20 schools, some 520 copies of the publications being ordered. The Report on Significance of Tests of Petroleum Products is in use by eight schools with some 200 copies required.

Another compilation which is in wide usage is that sponsored by Committee D-13 on Textile Materials. This is used in more than twelve schools who have courses in textile engineering or involving textiles with over 325 copies distributed.

Other special compilations of standards which have found a place in specific courses are the one on coal and coke and the Manual on Refractory Materials.

OTHER PUBLICATIONS

In addition to compilations of standards, a number of other A.S.T.M. technical publications are used in engineering schools. These include the Symposium on Radiography and X-ray Diffraction, the Manual on Presentation of Data, Report on Service Characteristics of Light Metals and Alloys, and others.

The Society's policy of having copies of its specifications and tests available in separate form is apparently of service to various schools, since during the period studied more than twelve schools ordered about 1100 copies of various specifications, test methods and recommended practices.

SIGNIFICANCE OF USE

In addition to group orders which are received for the various compilations and volumes, it has been noted that there are a large number of engineering faculty members in addition to those affiliated with A.S.T.M. who obtain copies of the books when their attention is directed to the possibilities of using the publications in their courses. It can be assumed that these educators make effective use of some of the information and data given in the book.

As a result of the procedure followed in developing standards, in soliciting technical papers from individual authors and the preparation of symposiums by outstanding authorities (in numerous cases the symposium reviewed by a special editorial committee) the data and information published are considered authoritative. Often the results in a publication are obtained only after laborious research work and other methods, and frequently information is compiled from a number of sources. Thus the books afford in compact, convenient form, data considered of much importance.

Obviously, if these data and information are to be of great utility, they must be used not only by men in industry today, but should be studied by future engineers.

As previously mentioned, greatly reduced prices are in effect on all publications used in schools. This includes separate copies of specifications, the Book of Standards and other volumes. Full information on prices of publications for student use can be obtained from the Society Headquarters.

Committee on Materials and Testing Formed by British

PARTLY as an outgrowth of the work of the British Committee of the International Association for Testing Materials and partly because of a realization of the need in Great Britain for some unified approach to the subject of materials testing, some 22 engineering and industrial institutions and societies have formed a Joint Committee on Materials and Their Testing in order to coordinate the British activities in this field. Many members of the Society may be interested in information regarding the work the new British committee is to do:

"It is expressly understood that this new body shall not absorb or replace in any way the activities of any existing technical organization; its essential object is to supplement with regard to materials and their testing the present activities of the cooperating organization to an extent and in a manner as shall be agreed. These organizations have therefore agreed that the terms of reference of the Joint Committee shall be to act as the British National Organization in matters relating to materials and their testing with the following objects, namely: –

"1. To promote joint discussions on the wider aspects of these subjects falling within the terms of reference.

"2. To assist a cooperating Institution or Society in the presentation of a paper or group of papers dealing with a more detailed aspect of one of the subjects falling within the terms of reference.

"3. To undertake those duties with respect to international matters which properly devolve on the Joint Committee in accordance with its terms of reference.

"Essentially, the work of the Joint Committee will divide into two fields of activity, national and international, of which the former will no doubt be of major importance. As a commencement in this field the committee is now engaged in making arrangements for a general discussion on the subject of the Notched Bar Test to be held in Manchester in the early autumn of the present year. The activities of the International Association for Testing Materials in Great Britain have been hitherto entrusted to the keeping of a British Committee; at the conclusion of the London Congress of the International Association for Testing Materials held in April, 1937, the new Joint Committee took over the representation in this country of all matters connected with the International Association."

The first chairman is Dr. H. J. Gough, largely through whose initiative the Joint Committee was formed.

Symposium on Plastics at 1937 Regional Meeting in Rochester

Spring Group Meetings to Be Held During Week of March 7

When the 1938 Regional Meeting of the Society gets under way in Rochester, N. Y., on March 9, and the various committees begin their meetings during Committee Week, extending from March 7 through March 11, it will have been just 149 years according to the records, since Ebenezer ("Indian") Allan erected the first buildings in Rochester, these consisting of a saw mill and grist mill. It was about 25 years later, however, in 1817, before real community life existed and the village was incorporated. Since that time Rochester has grown until, according to the census of 1930, Rochester and its Metropolitan area include over 402,000 inhabitants.

It is expected that all meetings of the Society will be held at the Seneca Hotel.

General arrangements for the meetings will be in the charge of a local committee of A.S.T.M. members headed by I. C. Matthews, Research Chemical Engineer, Research Laboratories, Eastman Kodak Co., with O. L. Angevine, Executive Secretary, Rochester Engineering Society, which holds membership in A.S.T.M., as secretary of the local group. All Rochester members of the Society will serve as members of the local committee and through the various subcommittees which will be appointed will handle specific details for the meetings.

The technical feature of the Regional Meeting will be a Symposium on Plastics to be sponsored by A.S.T.M. Committee D-20. The symposium committee is composed of the chairman of the Committee on Plastics, W. E. Emley, Chief, Division of Fibrous and Organic Materials, National Bureau of Standards, with personnel comprising the five chairmen of the D-20 subcommittees and a representative of the local Rochester committee. The complete personnel is as follows:

W. E. Emley, *Chairman*
H. M. Richardson, Plastics Dept., Pittsfield Works, General Electric Co.
J. C. Pitzer, Chemist, The Formica Insulation Co.
L. M. Currie, National Carbon Co.
H. W. Paine, Chemical Director, E. I. du Pont de Nemours and Co., Inc., Plastics Dept.
G. M. Kline, Chief, Organic Plastics Section, National Bureau of Standards
Louis Shnidman, Laboratory Director, Rochester Gas and Electric Corp., representing the Rochester Committee

The chairman of the Plastics Committee's subgroups are securing papers on the subjects within their respective scopes. The papers which are in course of development include the following:

A Revision of the Thermal Properties of Plastics and the Methods for Measuring Them—W. A. Zinzow, Bakelite Corp.

Flow Relations of Thermal Plastic Materials—C. H. Penning and L. W. Meyer, Tennessee Eastman Corp.

Permanence of Plastics—G. M. Kline, National Bureau of Standards.

The Properties of an Ideal Plastic—A. F. Randolph, E. I. du Pont de Nemours and Co., Inc.

Hardness as Applied in the Plastic Industry—J. C. Pitzer, Formica Insulation Co.

It is anticipated that there will be one additional paper included. The committee is proceeding on the premise that the papers will be prepared somewhat from the general interest standpoint and will not be drafted specifically to reach technologists in the plastics field.

There is a growing interest in the subject of plastics, and their use has increased tremendously in recent years. Consequently the symposium should have quite an appeal and the data and information given doubtless will be of much value to those who are concerned with this field.

Group Meetings of Committees

As indicated above, the 1938 Spring Group Meetings of A.S.T.M. Committees will be in progress from Monday, March 7, through Friday, March 11. It is expected that a large number of the committees will take advantage of Committee Week to hold meetings. To date some ten standing committees have signified their intention of meeting and a number of others will participate as in the past. Further information on room reservations, announcements of committees which will meet and other related information will be given in the January Bulletin, and transmitted in a special communication to the members of the committees participating.

Rochester

Rochester, the third largest city in New York State, is located on the south shore of Lake Ontario, approximately 380 miles west of New York City and 70 miles east of Buffalo. It is noted for a number of factors, and its industries include the Eastman Kodak Co., Bausch & Lomb Optical Co. and the Taylor Instrument Co., which are among the largest of their kind in the world. It is the seat of the University of Rochester and the Eastman School of Music, now carrying an endowment of over $80,000,000, making it one of the richest schools in the country.

The city is served by a number of railroads, including the New York Central, Lehigh Valley, Baltimore & Ohio, Erie and Pennsylvania. There are a number of excellent hotels in addition to the Seneca.

Another Use of Society Standards

A review of the recently revised edition of the Master Specifications for Reconditioning issued by the Appraisal-Reconditioning Division of the Home Owners' Loan Corporation shows that references are made to many A.S.T.M. standards. Materials which according to the H.O.L.C. Master Specifications are to meet all requirements of the latest A.S.T.M. standards involve such items as cement, lime, reinforcing steel, various types of masonry building units, structural steel, cast iron and wrought iron. Other materials required to conform to current specifications include copper sheets, quicklime, hydrated lime, gypsum plaster and gypsum lath. The Master Specifications were designed as a guide instrument for use by reconditioning supervisors, contractors and others. It is indicated in the foreword that successful use of the Master Specifications will provide simplicity and brevity in the preparation of individual job specifications, promote higher standards and better suitability of materials and workmanship and remove doubt and uncertainty from bidding and establish better understanding and accord between the Corporation, Home Owners and Contractors.

Standards in Building Codes

SPECIAL attention has been directed to building codes through the recent ordinance adopting a new building code for New York City. This code, as adopted, has been revised and amended to conform with state legislation establishing a new city charter for the large city of New York. The new building code, together with administration of the new city charter, is to become effective on January 1, 1938.

There are many of the more important municipal and state building codes which make use of A.S.T.M. standards either by verbatim quotation or by referring to the title and designation of the standard and in this way incorporating it in the code. In addition to the codes that have come to our attention, there are undoubtedly a number of others which may be patterned on the more important leading codes which in turn embody references to the specifications and tests of the Society. At one time there appeared in the A S T M BULLETIN certain articles pointing out the use of the Society's specifications in codes. One of the codes which makes extensive use of our specifications is the Uniform Code recommended by the Pacific Coast Building Officials Conference. This code is now in force in more than 180 municipalities in the United States.

In a recent article in *Engineering News-Record,* G. E. Strehan, Consulting Engineer, points out that the old building code for New York which had been in effect for over 20 years and which was considered by many a national model for that time, still stands as a model document for safe building regulation, a credit to its framer, Rudolph P. Miller, for many years closely associated with building construction in New York City. (Mr. Miller has been very active in the work of the Society and is at present chairman of Committee C-5 on Fire Tests of Materials and Construction and is also chairman of the Building Code Correlating Committee functioning under A.S.A. procedure.)

While the history of the new code and its development by a group of technical committees, organized through the active work of The Merchants' Association of New York, of which G. H. McCaffrey is Director of Research, and other points in connection with the code are extremely interesting, the code has been critically reviewed in a number of publications and its discussion here must be limited primarily to brief comments on its use of standard specifications. Mr. McCaffrey has pointed out[1] that generally the old code requirements for thickness, weight and strength of materials were on a rule of thumb basis. The new code substitutes for them the standard specifications of A.S.T.M. or those of similar nationally recognized bodies wherever possible. The requirements are so set up that the way is open for the use of new materials or construction methods provided specific strength requirements on the basis of standard tests are met. In general, the new code provides for a better application of present-day materials and improvement in methods of quality and manufacture and construction.

A.S.T.M. STANDARDS INCORPORATED

A review of a draft of the code as approved by the Board of Aldermen and printed on July 9, 1937, has been made to ascertain what A.S.T.M. specifications and tests are incorporated. In view of the widespread influence of the code, it is believed a list of the standards referred to may be of interest. Materials covered in the code by A.S.T.M. standards include the following:

- Steel for Bridges (A 7)
- Structural Nickel Steel (A 8)
- Steel for Buildings (A 9)
- Billet-Steel Reinforcement Bars (A 15)
- Rail-Steel Reinforcement Bars (A 16)
- Carbon-Steel Castings (A 27)
- Cast-Iron Pipe (A 44)
- Gray-Iron Castings (A 48)
- Welded Wrought-Iron Pipe (A 72)
- Cast-Iron Soil Pipe and Fittings (A 74)
- Cold-Drawn Wire for Reinforcement (A 82)
- Structural Silicon Steel (A 94)
- Black and Hot-Dipped Pipe (A 120)
- Structural Rivet Steel (A 141)
- Copper Pipe (B 42)
- Brass Pipe (B 43)
- Quicklime (C 5)
- Hydrated Lime (C 6)
- Portland Cement (C 9)
- Clay Sewer Pipe (C 13)
- Fire Tests (C 19)
- Gypsum (C 22)
- Compression Test Specimens (C 31)
- Structural Clay Tile (C 34)
- Compression Tests of Concrete (C 39)
- Organic Impurities in Sands (C 40)
- Gypsum Partition Tile (C 52)
- Building Brick (C 62)
- Testing Brick (C 67)
- High-Early-Strength Portland Cement (C 74)
- Structural Clay Tile (C 112)

MIAMI BUILDING CODE

Another building code adopted during 1937 is that of the City of Miami. This code was initiated and co-sponsored by the Miami Builders' Exchange. There are many references in the code to specifications issued by the Society including those covering the following materials: various types of brick, cast iron, cast steel, portland cement, fire tests, gypsum and gypsum block or tile, hollow clay tile, hydrated and quick lime, reinforcing steel for concrete, and structural steel.

Offers of Annual Meeting Papers

COMMITTEE E-6 on Papers and Publications is extending to each member the customary invitation to offer papers for presentation at the 1938 annual meeting in Atlantic City on subjects relating to the properties and testing of engineering materials.

In order that as many as possible of the technical papers and committee reports can be preprinted in advance of the meeting, it is desirable that the program be developed early. Committee E-6 has fixed February 15 as the limiting date for receipt of offers but members who may be considering the submission of a paper are urged to send their offers to A.S.T.M. headquarters *as soon as possible.* Suitable blanks which should be used in sending the necessary information with respect to the offer of a paper can be obtained from Society headquarters. Each offer must be accompanied by a summary of the proposed paper in such detail that its scope is clear and also to point out features that in the author's opinion make the paper a desirable one for presentation and discussion.

Invitations to submit papers are not limited to A.S.T.M. members, many outstanding technical contributions to our *Proceedings* having been made by men who were not affiliated with the Society.

The Committee on Papers and Publications in its review of the papers offered endeavors to develop a balanced technical program. The committee welcomes suggestions of pertinent subjects from members who may not wish to offer papers.

[1] George H. McCaffrey, "New Requirements, Use of Standards Feature New York's 1937 Building Code," *Industrial Standardization,* Vol. 8, No. 9, September, 1937, p. 236.

Study of Conical Mandrel Test for Attached Lacquer Films

By H. G. Arlt[1]

THE distensibility of organic finishes has been determined for some years by bending finished panels around cylindrical mandrels, the mandrels in common use varying from $\frac{1}{16}$ in. in diameter to somewhat larger than 1 in. This test can be performed by clamping the finished panel and the mandrel in a vise and wrapping the panel around the mandrel manually. A device employing six mandrels ranging in size from $\frac{1}{8}$ to 1 in. was designed some time ago[2] with a wrapping mechanism to insure a perfect wrap at all times (Fig. 1). The upper surfaces of the wrapped specimens are elongated an amount which is an inverse function of the radius of curvature of the bend and a direct function of the thickness of panel stock used. A detailed discussion of the distensibility of the films appears in the appendix to this paper. Recently Group 6 of Subcommittee XXV on Cellulose Ester Coatings of the Society's Committee D-1 on Paint, Varnish, Lacquer, and Related Products, undertook a simplification of this machine which has resulted in the design of a conical mandrel test apparatus (see Fig. 2).

A preliminary effort to determine the characteristics of the apparatus and to uncover those details of technique which should be controlled was conducted at Bell Telephone Laboratories on the experimental conical mandrel test apparatus.

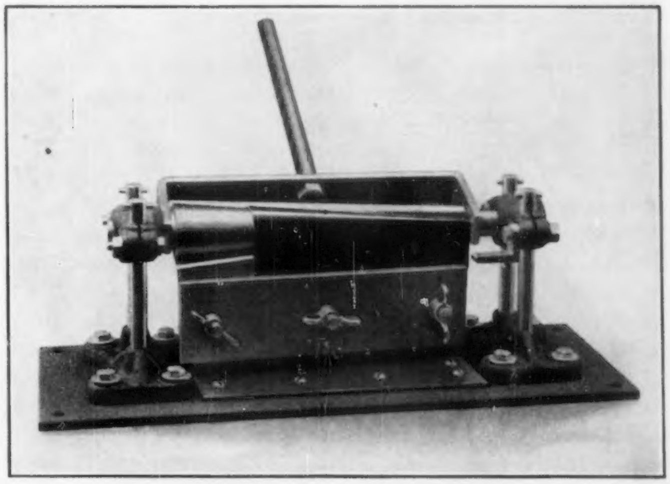


FIG. 2.—Conical Mandrel Test Apparatus

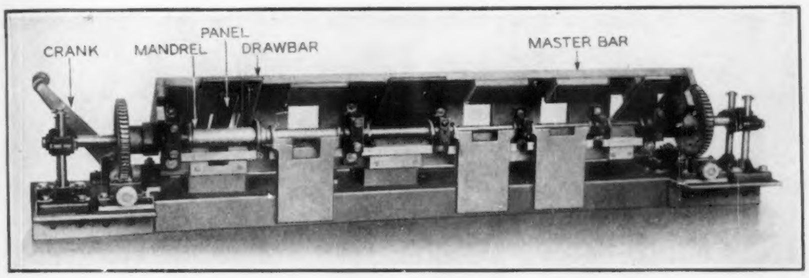


FIG. 1.—Cylindrical Mandrel Test Apparatus.

APPARATUS

The apparatus consists essentially of a cone 8 in. in length having a diameter of $1\frac{1}{2}$ in. at the base and $\frac{1}{8}$ in. at the smaller end. A bending mechanism is provided to wrap a finished panel closely around the mandrel. This device permits the elongation of finished coatings for from 2.2 to 28 per cent when applied to $\frac{1}{32}$ in. (No. 22 gage) thick panels of brass or steel.

DETERMINATION OF ELONGATION

In determining the percentage of elongation at any diameter of the conical mandrel, it is assumed that the degree of bending at each point is equivalent to the bend which would result on a cylindrical mandrel of the same diameter. The percentage of elongation of films fixed to metals has been determined experimentally when bent over several cylinders of different diameters and for several base materials. This information is contained in the Appendix.[3] From this information Figs. 3, 4, and 5 were developed which represent the relation between percentage of elongation and axial distance along the conical mandrel for cold-rolled steel, annealed brass and for $\frac{3}{4}$ hard brass base materials $\frac{1}{32}$ in. thick. These curves were developed based on the following formula:

$$Y = 1.5 - 0.172 \cos \alpha \times X$$

where

Y = the diameter of the cone at distance X,
X = distance from base of cone, and
α = the angle formed by the axis and any element of the cone.

Since α is small, $\cos \alpha$ is sensibly equal to 1 (actually 0.9963) and the above equation may be simplified to

$$Y = 1.5 - 0.172\,X$$

PROCEDURE

Three nitrocellulose lacquers were formulated by G. R. Ensminger of the duPont Company for this study. These materials were applied by atomized spray on 3 by 6 in. cold-rolled steel panels at uniform thicknesses of 0.001 and

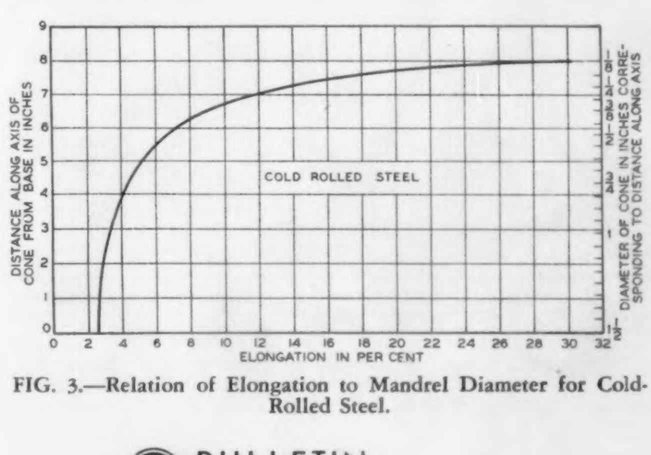


FIG. 3.—Relation of Elongation to Mandrel Diameter for Cold-Rolled Steel.

[1] Bell Telephone Laboratories, Inc., New York City.
[2] A. E. Schuh, "Evaluation of Industrial Finishes," *Industrial and Engineering Chemistry*, Vol. 23, December, 1931, pp. 1346-1352.
[3] See p. 7.

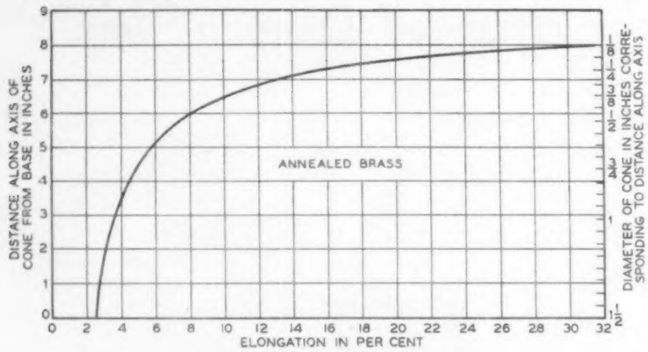


FIG. 4.—Relation of Elongation to Mandrel Diameter for Annealed Brass.

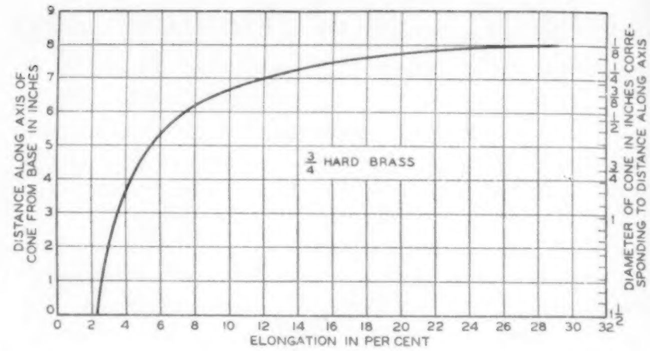


FIG. 5.—Relation of Elongation to Mandrel Diameter for 3/4 Hard Brass.

0.002 in. These test panels, were then aged for two weeks at 125F. Prior to testing, the panels were conditioned for 24 hr. at the temperature and humidity conditions indicated in Tables I, II, and III. The tests were arranged to compare results on the conical mandrel test with similar results on panels bent over cylindrical mandrels of various diameters and also to ascertain whether the conical mandrel test was sufficiently reliable to determine the well-known[4] effects of variation in temperature and humidity conditioning on the flexibility of lacquer coatings.

The panels were bent around both the conical and cylindrical mandrels at a rate of approximately 14 sec. for 180 deg. of bend.

TABLE I.—COMPARISON OF MANDREL TESTS
77 F. and 50 per cent relative humidity

Panel	Thickness, in.	Cylindrical Mandrel Test: Elongation, per cent	Cylindrical Mandrel Test: Type of Failure	Conical Mandrel Test: Elongation, per cent	Conical Mandrel Test: Type of Failure
A-1	0.00096	<13.9 > 8.9	Cohesional	12.8 11.0 12.4	Cohesional
				12.1 Avg.	
A-2	0.00191	<13.9 > 8.9	Cohesional	11.2 12.0 13.0	Cohesional
				12.1 Avg.	
B-1	0.00093	< 3.2	Adhesional	< 2.8 < 2.8 < 2.8	Adhesional
				< 2.8 Avg.	
B-2	0.00234	< 3.2	Adhesional	< 2.8 < 2.8 < 2.8	Adhesional
				< 2.8 Avg.	
C-1	0.00094	< 3.2	Adhesional	< 2.8 < 2.8 < 2.8	Adhesional
				< 2.8 Avg.	
C-2[a]	0.00194	> 6.6 < 8.8 > 6.6 < 8.8 > 3.3 < 4.4		5.1 11.2 3.2	Adhesional
Average ...	....	6.4	....	6.5	

[a] The distensibility of the 2-mil coating of material C, seems to be particularly sensitive to small changes in adherence. Sections of the panel seem to show poor adherence at which points adhesional cracking occurs.

[4] Schuh and Theurer, "Measurement of Distensibility of Organic Finishes," *Industrial and Engineering Chemistry,* Analytical Edition, January 15, 1937, Vol. 29, pp. 9-12.

In order to determine whether cracks in the films under test would propagate along the axis of the conical mandrel due to stresses introduced in the panel by the conical shape of the mandrel as contrasted with the simple bending stress resulting from the use of a cylindrical mandrel, panels finished with 1 and 2 mil thicknesses of each of the three materials were scored through to the base material at 1 in. intervals and then bent around the conical mandrel. This check indicated rather clearly that the additional stresses involved in the use of the conical mandrel do not seem to be large enough to affect the results appreciably. For instance, a rather brittle material with very poor adhesion characteristics showed small cracks over a relatively large distance along the conical mandrel. The character of these cracks appeared to be the same whether the panel was scored or not.

DISCUSSION

The results of Table I which provide a comparison of the cylindrical and conical mandrels give approximately the same percentages of elongation regardless of which mandrel is used. The possible exception is in the case of the 2 mil coating of material C where the results were very erratic on both the cylindrical and conical mandrels. The data, of

TABLE II.—EFFECT OF HUMIDITY AND TEMPERATURE CHANGES ON THE DISTENSIBILITY OF THREE LACQUERS
Determinations on conical mandrel test

Relative Humidity	50	50	50	35	50	90	90
Temperature	61 F.	77 F.	85 F.	77 F.	77 F.	83 F.	95 F.
Panel	Elongation, per cent						
A-1	10.4 10.5 9.5	12.8 11.0 12.4	10.8 13.0 12.4	12.2 12.8 10.2	12.8 11.0 12.4	>28 20 14.2	>28
Average	10.1	12.1	13.1	11.7	12.1	20 App.	
A-2	8.4 9.8 8.7	11.2 12.0 13.0	11.8 11.5 10.8	10.2 8.2 8.4	11.2 12.0 13.0	>28 15 15	>28
Average	9.0	12.1	11.4	8.9	12.1	20 App.	
B-1	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8
B-2	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	2.9
C-1	<2.8	<2.8	<2.8	<2.8	<2.8	<2.8	3.0
C-2	<2.8	5.1 11.2 3.2	11.2 3.4 11.2	4.8 3.3 3.6	5.1 11.2 3.2	11.2 12.4 15.0	4.9 5.0 2.8
Average	....	6.5	8.5	3.9	6.5	12.9	4.2

TABLE III.—EFFECT OF TESTING CONDITIONS (TEMPERATURE AND HUMIDITY) UPON THE DISTENSIBILITY OF THREE LACQUERS PREVIOUSLY CONDITIONED AT 77 F. AND 50 PER CENT RELATIVE HUMIDITY. CONICAL MANDREL TEST

Tested within 5 min. after removal from 77 F. and 50 per cent relative humidity.

Panel	77 F. 50 per cent relative humidity	95 F. 90 per cent relative humidity
A-1	12.8 11.0 12.4	17.6 15.4 16.2
Average	12.1	16.4
A-2	11.2 12.0 13.0	15.0 11.2 12.9
Average	12.1	13.0
B-1	< 2.8 < 2.8 < 2.8	< 2.8 < 2.8 < 2.8
Average	< 2.8	< 2.8
B-2	< 2.8 < 2.8 < 2.8	< 2.8 < 2.8 < 2.8
Average	< 2.8	< 2.8
C-1	< 2.8 < 2.8 < 2.8 < 2.8	< 2.8 < 2.8 < 2.8 < 2.8
Average	< 2.8	< 2.8
C-2	5.1 11.2 3.2	15.0 11.2 3.0
Average	6.5	9.7

course, are very limited and should be confirmed by a more comprehensive study employing more materials in the range of elongation from 3 to 30 per cent. It is suggested that the committee outline a cooperative study to obtain such data.[5]

In Table II it is apparent that the conical mandrel test is quite effective in determining the effect of humidity and temperature changes on the distensibilities of the lacquers tested. No further work along this line should be necessary. The data of Table II again emphasize the necessity for a very definite control of temperature and humidity conditions prior to and during the determination of physical properties such as distensibility.

In view of the scarcity of controlled temperature and humidity conditions in various laboratories at the present time, an attempt was made to determine the effect of conditioning the samples (for instance, in cabinets) and then removing to an outside room condition for test purposes. Unfortunately the range of values available on lacquers A, B and C do not give sufficient information to indicate whether this procedure is feasible. It is suggested that the committee give further consideration to this matter.[5]

Elongation data are available for $\frac{1}{32}$ in. thick panels of cold-rolled steel, $\frac{3}{4}$ hard brass and for annealed brass. It is advisable that similar data be established for other base materials. It is suggested that the committee proceed with this work. In order to simplify this work and keep it at a minimum, it is also suggested that a uniform thickness of $\frac{1}{32}$ in. (No. 22 gage) be used for panels of all materials to be used for conical mandrel tests.

[5] Such work is now under way.

CONCLUSIONS

1. From the limited data available at this time, it appears that the conical mandrel test gives the same results as the cylindrical mandrel test with the advantages of lower cost, simpler operating technique, and definite instead of limiting values. Further work in confirming this is suggested.
2. The conical mandrel as designed does not appear to introduce additional stresses of such magnitude as to give different elongation values than are obtained on cylindrical mandrels of the same range of diameters.
3. The conical mandrel test is a useful tool in determining changes in distensibility of lacquer films due to different environments of temperature and humidity.
4. The conical mandrel test appears to be a useful tool for formulation evaluation in that it is capable of accurately differentiating the effects of changes in composition.
5. Elongation values are available for one panel thickness of three base materials. Values for the same thickness of other materials should be established.
6. An exact procedure of testing with the conical mandrel should be established.

APPENDIX

Distensibility of Attached Films

Measurement of Elongation Obtained:

Assuming elastic conditions of the base material (which, of course, is not the case but is useful in establishing a limiting condition), the theoretical elongation for each mandrel size can be calculated. Under this assumption the moduli of elasticity for tension and compression are equal in magnitude and the neutral plane (that is, the plane where the bent bar is neither elongated nor compressed) is at the centroidal axis of the specimen. In a bar having a thickness, t, bent around a mandrel of radius, r, the neutral plane would be located at a distance $t/2$ from the surface of the bar, and the perimeter of the bent section along the neutral axis, assuming the specimen to be bent through 180 deg., is equal to $\pi\ (r + t/2)$. At the upper surface of the bar, the perimeter would be equal to $\pi\ (r + t)$, and the elongation of the bar at the surface would be:

$$\text{elongation} = \pi\ (r + t) - \pi\ (r + t/2) = \pi\ (t/2)$$

and the percentage elongation at the surface would be:

$$\text{percentage elongation} = \frac{\pi\ t/2 \times 100}{\pi\ (r + t/2)} = \frac{t}{2r + t} \times 100$$

Using this formula, the theoretical elongation (under elastic conditions) at the surface of the specimens can be calculated for any thickness of panel and mandrel size, resulting in the following values for three panel thicknesses and six mandrel sizes:

ELONGATION, PER CENT

Panel Thickness, in.	Mandrel Size = 2 r					
	1 in.	$\frac{3}{4}$ in.	$\frac{1}{2}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
$t = \frac{1}{64}$	1.5	2.0	3.0	4.0	5.9	11.1
$t = \frac{1}{32}$	3.0	4.0	5.9	7.7	11.1	20.0
$t = \frac{1}{16}$	5.9	7.7	11.1	14.3	20.0	33.3

Actually the specimens are distended considerably past their elastic limit, so that the elongations obtained with the

mandrel test are considerably higher than the values computed above. Since it is impossible to calculate the position of the neutral plane when the elastic limit has been exceeded, a special jig was developed to measure the elongation directly.

This jig (Fig. 6) consists of two forks for holding the mandrel and panel in position and a roller with which the panel is tightly wrapped around and held against the mandrel.

Method of Measuring Elongation with Jig:

Two parallel gage scratches are made with a sharp stylus on the edge of the specimen and are so located that when it is wrapped around the mandrel the included angle between the scratches will be approximately 180 deg. In locating the scratches, it is necessary to make sure that they will be within the section of the panel which after bending is tightly wrapped against the mandrel. Having located the scratches, the linear distance between them is measured to within 0.0002 cm. with a Star Comparator. The specimen is then clamped in the jig and the roller brought down tight against it. The roller is then drawn around which causes the panel to be tightly wrapped and secured against the surface of the mandrel. In order to hold the jig in this position, the forks are held together with a C clamp. The clamped jig is then rigidly mounted on the table of the Star Comparator. Each of the gage scratches is then made to coincide with the vertical cross hair of the measuring eyepiece while the horizontal cross hair is tangent to the curvature of the upper surface of the specimen. The angle reading is taken at each of these points. The difference between the two angle readings is a measure of the included angle formed by the two gage scratches and the radii drawn coincident with the scratches. The angle readings are read in minutes and seconds to a precision of $\pm$ 5 sec. The total diameter of the mandrel and the bent specimen is also determined. From these data the percentage elongation at the surface of the specimen can be calculated, using the following formula:

$$\frac{a\pi}{180} r = L \text{ and}$$

$$\text{percentage elongation} = \frac{L\text{-}d}{d} 100$$

where

a = angle in degrees,
L = arc length,
r = radius of curvature for system (mandrel radius + t), and
d = original distance between scratches.

The elongations for three metals were obtained by this method for the 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{1}{4}$ in. mandrels. The thickness of panel stock used was $\frac{1}{32}$ in. The average of three determinations of the elongation obtained with five mandrel sizes for $\frac{3}{4}$ hard brass, annealed brass and for cold-rolled steel was plotted on log-log paper (Fig. 7). These plots are very satisfactory straight lines and it is therefore possible to extrapolate the probable percentage elongation for the $\frac{1}{8}$ in. mandrel for which no actual measurements were possible with the available jig. The most probable elongations as obtained from the straight line drawn through the experimental points are recorded below:

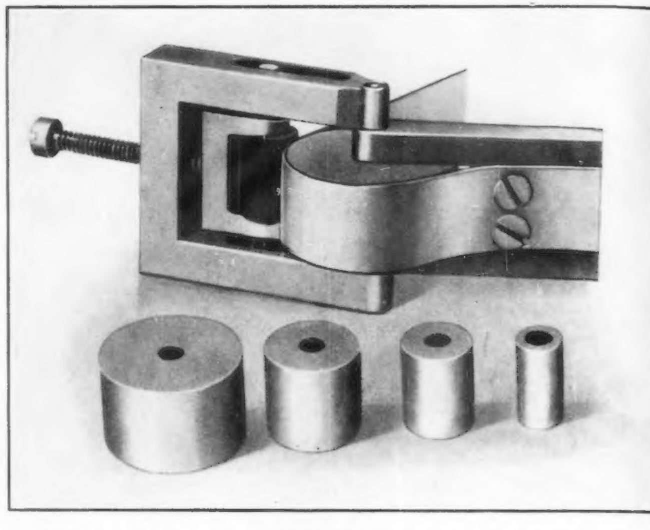


FIG. 6.—Jig for Determining Elongation of Bent Metal Strip.

ELONGATION AT VARIOUS MANDREL SIZES, PER CENT

	1 in.	$\frac{3}{4}$ in.	$\frac{1}{2}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
$\frac{3}{4}$ hard brass......	3.4	4.6	6.9	9.6	14.2	29.1
Annealed brass....	3.6	4.9	7.5	10.3	15.9	33.5
Cold-rolled steel...	3.3	4.4	6.7	9.0	13.8	28.0

Correction for Surface Elongation When Film Thickness Exceeds 0.001 in.:

When the thickness of coating of the finish applied to the specimen to be bent is much more than 0.001 in. a correction should be added to the above elongations to compensate for the increased radius of curvature. On the assumption that the paint films are comparatively weak in tensile properties and therefore do not appreciably change

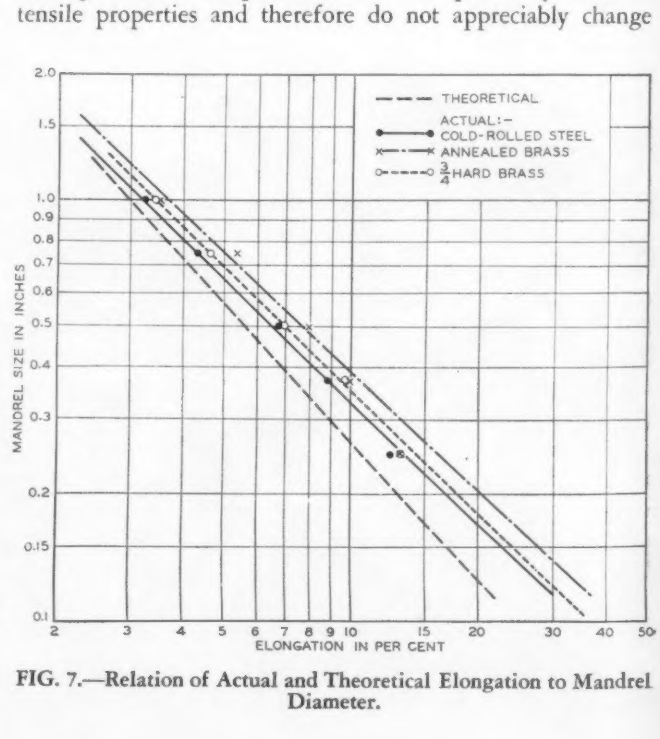


FIG. 7.—Relation of Actual and Theoretical Elongation to Mandrel Diameter.

the bending characteristic of the specimen, a suitable correction factor can be computed and in the following table, the correction to be added per mil of coating for each of the mandrel sizes and for three types of metal used, as calculated, are given:

	k = Correction to be added per mil of coating, per cent					
	1 in.	$\frac{3}{4}$ in.	$\frac{1}{2}$ in.	$\frac{3}{8}$ in.	$\frac{1}{4}$ in.	$\frac{1}{8}$ in.
$\frac{3}{4}$ hard brass	0.21	0.26	0.38	0.50	0.73	1.38
Annealed brass....	0.21	0.26	0.38	0.50	0.74	1.43
Cold-rolled steel...	0.21	0.26	0.38	0.50	0.73	1.37

For example, when the total film thickness is 2 mils, the actual elongation for a steel panel bent over a $\frac{1}{8}$ in. mandrel is $28 + 2(1.37) = 30.74$ per cent.

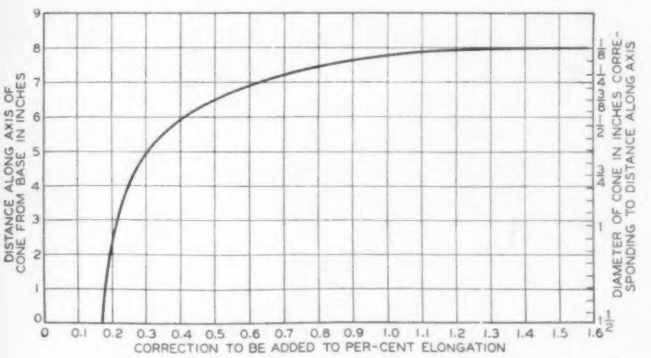


FIG. 8.—Correction for Thickness of Film.

A correction curve for thickness of film is given in Fig. 8. This curve is particularly arranged for use on attached films bent over the conical mandrel tester.

Committee on Electrical Alloys Has Active Meeting

At the series of meetings of Committee B-4 on Electrical-Heating, Electrical-Resistance and Electric-Furnace Alloys held in Washington, D. C., on November 4 and 5, a number of important actions were taken and definite progress was reported on several of the research and standardization projects. The series of meetings was under the direction of Dean Harvey, Westinghouse Electric and Manufacturing Co., and F. E. Bash, Driver-Harris Co., chairman and secretary, respectively, of Committee B-4.

Two of the subcommittees most recently organized presented interesting reports. The group on metallic materials for radio tubes and incandescent lamps has under way the preparation of standard methods of test covering filament materials, fine cathode tubing, mica parts, filament hook wire, and a tungsten wire brittleness test. The committee is continuing consideration of testing methods for the stiffness of wire and is making a study of a report on three types of testers. While its work at the present concerns chiefly the testing of wire and strip materials and fine tubing, it will gradually be extended to include consideration of other types of materials when results are obtained on these.

In its 1937 report, Committee B-4 indicated that because the electric furnace industry has had some difficulty due to the deterioration of resistors subjected to controlled atmospheres in electric furnaces, it was arranging for the organization of a new subcommittee to undertake the development of a suitable method of test to determine the durability of resistor alloys exposed to controlled atmospheres at high temperatures in electric furnaces. This new subcommittee has work in progress, both laboratory and field tests, on the effects of various atmospheres on electrical resistor material. Tests are being made at various temperatures on the individual components of the furnace atmospheres, as well as on the combination of them resulting from partially burned fuel gases. Tests are also being conducted with varying content of moisture and sulfur in the furnace atmosphere. Samples of specimens of a wide range of materials were submitted after exposure to different atmospheres and varying periods of time. The work has not as yet reached a stage where definite conclusions can be drawn.

The subcommittee concerned with life tests recommended a slight change in the Accelerated Life Test for Metallic Materials for Electrical Heating (B 76 - 36) providing for the substitution of a glass front in place of the metal slide used in the enclosure around the sample. The committee reported it would give consideration to the development of life test methods for materials used as furnace resistors. Based on the studies of the great amount of data that have been collected on life tests made at various temperatures, these data being plotted on semi-log paper, a straight line relationship between hours of life and test temperatures is indicated. This makes it possible to determine the life of a wire at other than test temperatures.

The work on electrical tests was advanced by the recommendation that proposed methods for the temperature resistance constants of sheet metals for shunts and precision resistors be approved as tentative. Based on studies which have been carried out in the field of mechanical tests, three methods of determining stiffness of wires have been referred to the subcommittee on metallic materials for radio tubes and incandescent lamps. This latter group has requested that consideration be given to standardizing test procedures for thin strip material.

In the field of wrought and cast alloys for high-temperature use, work is being considered on a high-temperature bend test in which the load is applied in different manners in each of two laboratories. The data will be correlated when the tests are completed. Additional work on warpage tests is under way at the University of Michigan, it was reported.

The projects on thermostatic metals are being continued actively and tests are being made to determine the minimum thickness of strip of thermostat metal which can be tested for flexivity by the present Tentative Method of Test for Flexivity of Thermoflex (Thermostatic Metals) (B 106 - 37 T). New specimen supports are being considered which avoid the use of knife edges and consequent need for a correction factor for transverse bending. A method for determining the effective modulus and safe operating temperature for thermostatic metals is under consideration.

Textile Committee Meets in New York City

Symposium Held on Test Methods

The regular Fall Meeting of Committee D-13 on Textile Materials was held in New York City, October 20 to 22. In addition to the attendance of 90 committee members, there were 26 guests present. Two general sessions of the main committee were scheduled and in addition, 18 of the 24 subcommittees held meetings with a good attendance reported at each.

The committee, in accordance with its policy of sponsoring symposiums on important topics in its field arranged for a Symposium on Test Methods in which the following five papers were presented:

TESTS FOR THE PHYSICAL PROPERTIES OF FIBERS—C. J. Huber, Director of Laboratories, United States Testing Co.
TESTS FOR THE PHYSICAL PROPERTIES OF YARNS—H. F. Schiefer, Physicist, National Bureau of Standards
TESTS FOR THE PHYSICAL PROPERTIES OF TEXTILE FABRICS—Ethel Phelps, Assistant Professor of Textiles and Clothing, University of Minnesota
ABRASION AND WEAR TESTING MACHINES FOR TEXTILES[1]—H. J. Ball, Professor of Textile Engineering, Lowell Textile Institute.
MICROSCOPIC TEST METHODS—E. R. Schwarz, Professor of Textile Engineering, Massachusetts Institute of Technology.

A banquet was held Thursday evening followed by a trip to the Hayden Planetarium.

ACTIONS ON STANDARDS

At the meetings a number of actions were taken on standards under the jurisdiction of the committee, the various recommendations being approved for submission to letter ballot of the committee. It was decided to recommend the adoption as standard of the Tentative Method of Test for Strength of Rayon Woven Fabric When Wet (D 415 - 35 T). Another action involved the inclusion of a method of determining the number of yards in a package in the Standard Methods of Testing and Tolerances for Cotton Sewing Threads (D 204 - 36). Extensive revisions of the Standard Methods of Testing and Tolerances for Tire Cord, Woven and on Cones (D 179 - 33), were approved at the meeting and it was decided to propose the withdrawal of Standard Specifications for 23/5/3 Carded American Tire Cord (D 298 - 29).

LIST OF ACTIVE PROJECTS

The committee has a large number of projects being carried on in the various subcommittees and their respective sections. For the information of members and for those who are concerned with the important work of this committee, a list of the projects follows:

1. Study of methods for determining evenness in cotton yarns.
2. Study of moisture regain in cotton yarns.
3. Method of test for strength of heavily plied cotton yarns.
4. Study of methods for determining sizing in gray and finished fabrics.
5. Study of methods for determination of twist in single yarns.
6. Calibration methods for testing machines.
7. Test methods and tolerances for rayon staple and spun rayon yarns.
8. Checking of methods of testing consumer fabrics (rayon underwear) against actual consumer wear.
9. Establishment of minimum standards for strength of rayon cloths used for different types of wearing apparel.
10. Definitions for wool, conditioning, conditioned, moisture equilibrium, standard condition, standard moisture regain, commercial moisture regain, sheetings, broadcloths and toweling.
11. Methods of conditioning samples before test.
12. Study of tolerances for standard relative humidity and temperature with reference to duration, frequency and extent of variations.
13. Development of a laboratory method for determining shrinkage in grease wool.
14. Method for determining length of wool fibers.
15. Establishment of physical characteristics of mohair which will lead to proper identification. Fineness of mohair is being studied.
16. Study of methods of determining sizings of various types in wool felt.
17. Test methods and tolerances for woolen and worsted yarns spun from wool mixed with fibers other than wool.
18. Classification of carpet wools.
19. Methods for determining weight of clean pile yarns and clean backing material in carpets.
20. Method of tuft length measurement.
21. Precision of the method for back thickness measurement in carpets.
22. Proper sample size for wool weight, total weight and total thickness of carpets.
23. Machine wear tests on carpets.
24. Chemical tests on carpets involving spotting, crocking and bleeding.
25. Length of test specimen for strength of jute yarn.
26. Development of a proposed standard for methods of test and tolerances for jute yarns, twines and roving.
27. A study of the number of tests to give a desired precision is being made by Section IV on Tire Fabrics of Subcommittee A-1 on Cotton and Its Products, also Subcommittee A-5 on Bast and Leaf Fibers and Their Products assisted by Subcommittee B-5 on Sampling, Presentation and Interpretation of Data.
28. Development of specifications for diaphragm bursting testers.
29. Study of the relation between rate of loading constant specimen-rate-of-load type testing machines and the strength of cotton yarns.
30. Study of methods employed for determining the water resistance of textiles.
31. Study of methods employed for determining the fastness to light of colored textiles.

It was announced that the 1938 Spring Meeting would be held in Washington, D. C., March 9 to 11. A Symposium on Textile Finishing Methods, sponsored by Subcommittee B-4 on Bleaching, Dyeing and Finishing, will be featured.

It is planned to exhibit at this meeting the Committee D-13 display held during the Society's Fortieth Annual Meeting in New York.

Arrangements for the series of meetings in New York were in charge of S. B. Walker of the United States Testing Co., Inc.; Prof. H. J. Ball, and W. H. Whitcomb, respectively chairman and secretary of Committee D-13, directed the various meetings.

Portion of D-13 Display at 1937 Annual Meeting in New York City

[1] This paper appears in the following pages of this BULLETIN.

Abrasion and Wear Testing Machines for Textiles[1]

by Herbert J. Ball[2]

Part I of this paper is devoted to a description of the mechanical features of textile abrasion or wear testing machines. Its sole purpose is to assemble in one place technical information on this subject. It is not the intent to compare the relative merits of the various machines. Part II contains a discussion of the problems involved in the abrasion or wear testing of textile materials.

The machines chosen for description in Part I are eleven in number. They represent those which are undoubtedly the best known to the textile testing interests in the United States and some which are not so well known. It has been the endeavor to include all commercial testers, using that term to signify those which may be purchased from their manufacturers or agents ready for use. Also included are other machines developed in the laboratories of certain industrial organizations and designed to meet their particular wear testing requirements. Others are described because they contain mechanical or other features which it is believed are of special interest.

To the extent that it was available, each description is intended to give the essential information in respect to the character of motion of the sample, the character of motion of the abradant, nature of the abradant and its size, size and number of samples, control of pressure between abradant and sample, control of tension on sample, size of abraded area, provision for removal of abraded material, automatic and recording features, over-all dimensions, and power requirements. It is expected that these data may be useful to those who wish to study the features which designers of abrasion testers have incorporated in their respective machines.

Part I—Description of Testing Machines

Amsler Wear Tester:

The Amsler wear testing machine is a commercial tester made by Alfred J. Amsler and Co., Schaffhouse, Switzerland, and sold in the United States and Canada by Herman A. Holz, New York City.

The wear-producing element of this machine is a so-called comb, in which the sample has been inserted. The comb is traversed, back and forth, lengthwise of the sample while the latter is held fixed in a horizontal position under a definite tension.

The comb consists of a frame containing four steel plates, each 2 mm. thick, set parallel to each other, and arranged in opposite pairs as shown in Fig. 1. The acting edges of all plates 1, 2, 3, and 4, are rounded and bear across the full width of the specimen.

It will be noted that the sample is abraded equally on both faces, and at the same time is symmetrically flexed in opposite directions through like angles. The frame which holds the plates is made in two parts and hinged so that the upper plates can be laid back to facilitate insertion of the sample. A maximum width of sample of 2 in. can be accommodated.

The comb is mounted on two ball bearings which roll on the horizontal bed of the machine. It is reciprocated through a distance of 5 in. 30 times per minute by a crank and connecting rod mechanism attached to each end of the frame. The sample of fabric is cut 12 in. long and 2 in. wide and inserted in the comb. The ends of the strip are secured in clamps which are fastened to two horizontally arranged steel

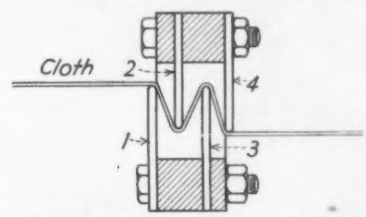


Fig. 1—Wear-producing Element, Amsler Tester

ribbons. These ribbons pass over guide pulleys and each is fastened at its other end to tension weights of equal amount. The length of each ribbon is so adjusted that when one of the weights rests on its support, the other hangs clear. In operation the weights alternately seat themselves and the tension on the fabric is always equal to the suspended weight. Weights are provided to give tensions from 2 lb. to 40 lb. by increments of 2 lb.

A counter, operated by one of the guide pulleys, records the number of double strokes of the comb. The counter ceases to operate when the sample breaks, and hence indicates the total number of abrasive strokes causing rupture even though the motor continues to run.

No special provision is made for removal of lint which collects between the plates and is cleaned out after each test.

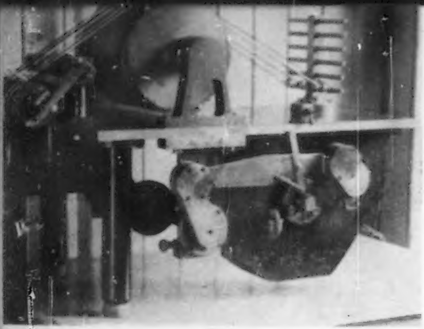
The abraded area is 4 in. long with a width equal to that of the sample. Larger machines having 6, 12, or more abrading units can be secured if it is desired to test more than one sample at a time.

A motor of $\frac{1}{5}$ hp. is direct-connected to a worm gear speed-reducing unit and supplies the motive power for the cranks which operate the comb. The machine can be placed on a bench or table, and the over-all dimensions are as follows: length, 48 in.; width, 12 in.; height, 20 in.

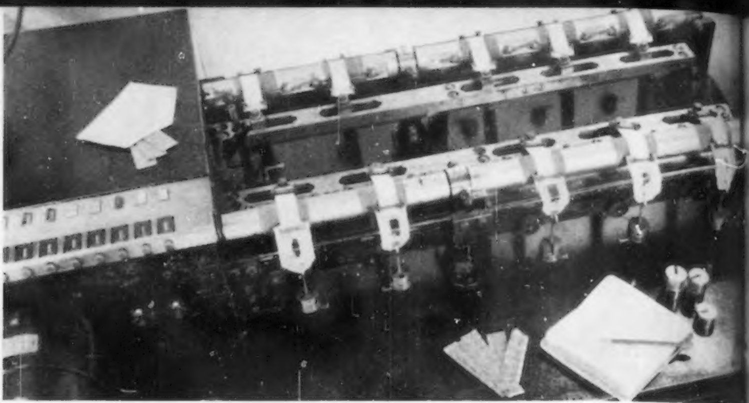
Amsler Wear Tester

[1] Presented at a Symposium on Test Methods, held during the Fall Meeting of A.S.T.M. Committee D-13 on Textile Materials, October 20 to 22, 1937, New York City.

[2] Professor of Textile Engineering, Lowell Textile Institute, Lowell, Mass.



Eaton's Machine



Macy's Tester

Eaton's Abrasion Machine:

The following description is of an abrasion machine for textiles developed in the laboratory of the T. Eaton Co., Ltd., Toronto, Canada. It is not a commercial machine.

The moving and abrasive element in this machine is a cylinder, approximately 7.5 in. in diameter and 9 in. long, placed with its axis horizontal. Four bronze plates, 0.62 in. thick, are bolted to and cover its surface. Two of them extend 4.25 in. along the circumference of the cylinder and are placed diametrically opposite each other. Each is cut with 22 grooves (5 to the inch), $\frac{1}{16}$ in. wide by $\frac{1}{8}$ in. deep, running parallel to the axis of the cylinder. The other two plates are placed between the two first mentioned, each one extending 8.4 in. along the circumference of the cylinder. Their surface is cut with 55 grooves (5 to the inch), $\frac{1}{16}$ in. wide by $\frac{1}{8}$ in. deep, inclined at an agle of about 40 deg. to the axis of the cylinder. The diagonal grooves in one plate are cut opposite in direction to those in the other.

The cylinder turns 66 complete revolutions per minute, made up of 11 complete cycles as follows: 3 revolutions in one direction, a momentary stop, then 3 revolutions in the opposite direction. This motion is obtained from an oscillating crank driving a quadrant-rack which engages a pinion on the cylinder-shaft.

A sample of the material to be tested is cut $1\frac{1}{2}$ in. wide and of any suitable length between a minimum of 3 in. and a maximum of 7 in. It is then hand-sewed to a base strap made of surgical webbing 1in. wide. The strap with the sample face down is laid over the top of the cylinder, and weights are attached which provide the pressure of sample on the cylinder. By stretching the sample slightly during the sewing operation, it is prevented from wrinkling. The arc of contact between the specimen and cylinder can be adjusted by raising or lowering the ends of this strap. The abraded area is 1 in. wide and its length may be varied from 1 to 5 in. The abrasive action is in the direction of the length of the sample. Four samples can be tested at one time.

Very little of the lint formed collects in the grooves in the cylinder plates but is cleaned out after each test. A reset counter records the number of cycles of motion of the cylinder. There is no automatic stop when the specimen is worn through.

The machine is driven by a $\frac{1}{4}$ hp. motor through a speed-reducing unit. The machine can be mounted on a bench or table and its over-all dimensions are as follows: length, 26 in.; width, 21 in.; height, 21 in.

Macy's Abrasion Tester:

The fundamental design of an abrasion tester developed in the Bureau of Standards of R. H. Macy & Co., Inc., New York City, under the direction of Mr. Ephraim Freedman, embodies the principles of the Dennis abrasion tester.

The moving elements are two parallel horizontal shafts, 36 in. long and $2\frac{1}{16}$ in. in diameter, with their axes about 7 in. above the base of the machine. They are oscillated through nearly one complete turn 68 to 70 times per minute. At five different points along their length, longitudinal slots have been cut for fastening a strip of abradant, thus providing for the testing of ten samples at a time.

The abradant commonly used is No. 320 fine or No. 150 rough metalite cloth, cut into strips $6\frac{3}{8}$ in. long by 3 in. wide. A piece is wrapped around the shaft and its ends are forced into the slot and held by a key. This tensions the strip and causes it to lie smoothly on the shaft. New abrasive is used for each test.

The sample of fabric to be tested is cut 5 in. long and $1\frac{1}{4}$ in. wide. It is laid over one of the strips of metalite cloth and clamps are attached to each end. The front clamp has weights attached to it which control the tension on the sample. It is arranged so that the rear clamp can be reciprocated $2\frac{1}{2}$ in. parallel to the axis of the shaft 13 times per minute, while the front clamp is pivoted and allows no such motion. This motion of the sample combined with that of the abradant has the effect of subjecting both sets of threads to a rubbing action partially in the direction of their length and partially transverse. The sample is abraded over a length of $1\frac{1}{2}$ in. and across its entire width.

A separate counter is provided for each of the ten abrading units to record the number of abrasive strokes given to the respective sample. As each sample breaks, it automatically stops the registration of its counter and extinguishes a colored signal lamp.

No special means are used for lint removal.

The machine is driven by a $\frac{3}{4}$ hp. motor, and requires a table space 3 by 5 ft. Its over-all height is $12\frac{1}{2}$ in.

Matthew's Cloth Wear Testing Machine:

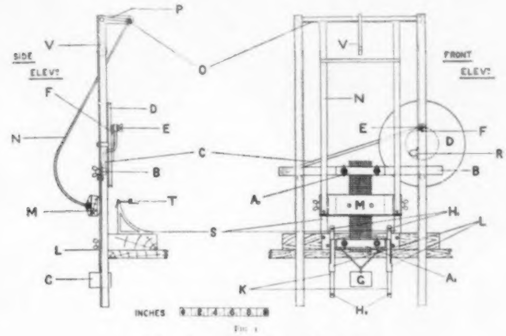
The following description is based on a paper by Matthew.[3] Dimensions have been secured in part by measurements from the scale drawings contained in the paper.

The specimen of cloth to be tested is of the strip test type, 12 in. long and with a ravelled width of 2 in. This is held in a vertical plane by horizontal clamps attached to each end, the distance between clamps being 8 in. The sample receives its motion from the upper clamp which is reciprocated horizontally, by means of a crank and connecting rod mechanism, 80 to 85 times per minute. This motion is adjustable from a maximum traverse of 2 in. on each side of a vertical center line through the specimen to a lesser value if desired.

The strip is tensioned by a weight attached directly to

[3] J. A. Matthew, "A Cloth Wear Testing Machine," *Journal*, Textile Inst., Vol. XXI, No. 11, November, 1930, p. T 546.

the lower clamp. The latter is arranged to move freely in vertical guides which are designed with sufficient clearance so that the clamp may also tip a few degrees out of the



Matthew's Wear Tester

horizontal. This freedom permits the sample to adjust itself partially to the changing position of its upper end without developing wrinkles at a point half way between the clamps where the abrasive action occurs.

The abradant is a block of carborundum of 120 grade grit 6 in. long by $2\frac{1}{2}$ in. wide by $\frac{1}{2}$ in. thick. The surface which is in contact with the cloth is one of the 6 by $2\frac{1}{2}$ in. faces which has been carefully rounded to a radius of 1.8 in. throughout its entire length by rubbing it down against a carborundum block of coarser grade.

The abradant, with its 6-in. dimension horizontal, is fastened to the end of a bent pendulum whose pivot is located on a level about 24 in. above the center of the specimen and in back of its plane. The arrangement is such that the pendulum is prevented from swinging down to its normal vertical position by contact of the abradant with the face of the tensioned sample thus creating a steady pressure in a horizontal direction between the two surfaces. This pressure can be regulated by varying the position of the pivot and by the attachment of weights to the end of the pendulum, and is determined by calibration.

The abrasive action occurs from the side to side movement of the sample past the fixed abradant. The motion is largely parallel to the width of the specimen but there is a small component parallel to its length. The wear, therefore, is not localized along a theoretical line of contact but forms a band, across the entire width of the specimen, about $\frac{1}{4}$ in. wide when the maximum traverse of the upper clamp is used. The motion creates a continual movement of one set of yarns over the other creating internal forces of friction between fibers and yarns, tends to break up any binding effect resulting from the finishing operations and thereby simulates certain actual conditions of wear. It was found also to be an effective means of removing the abraded material from the surface of the sample and no other provision for lint removal is made.

The machine is driven by an electric motor through a gear reduction unit. When the tensile strength of the threads running lengthwise of the specimen has been reduced to the value of the tension weight, the specimen breaks, the pendulum swings down to the vertical position and automatically breaks the electrical circuit. A counter records the number of reciprocations of the upper clamp during the test.

Exclusive of the motor and the gear reduction unit, the device has the following over-all dimensions: width, 25 in.; depth, 12 in.; height, 36 in.

The M.I.T. Abrasion Machine:

The M.I.T. Abrasion Machine was developed in the textile laboratory of the Massachusetts Institute of Technology, Cambridge, Mass. It is available from the Hamblett Machine Co., Lawrence, Mass., on special order.

In this machine the abradant is held stationary while the specimen to be tested is pulled back and forth beneath it and at the same time flexed through 180 deg.

In the frame of the machine, there is mounted at a height of 5 ft. from the floor a roller which can rotate on a horizontal axis. This roller is 9 in. long, is mounted in dust-proof ball bearings at each end, and is the support for both the sample and the abradant during the rubbing action.

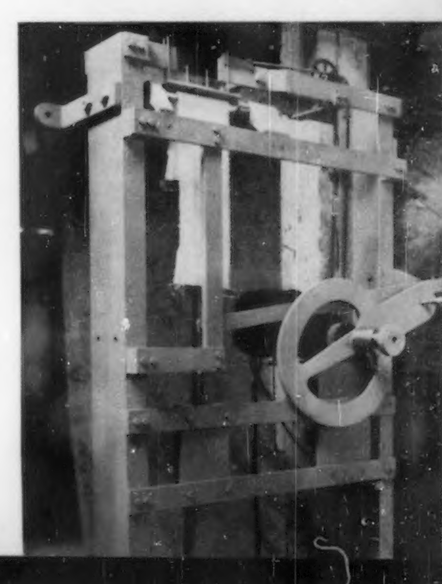
A sample of the material to be tested is cut 26 in. long by $6\frac{1}{2}$ in. wide, and clamps of suitable design, 7 in. long, are fastened to each end. The specimen is then hung over the roller, lengthwise, and one clamp is attached to a block which slides in vertical guides while the other is fastened to a dead weight tensioning device, free to fall but restrained from motion upward.

The sample receives its motion from its connection to the sliding block. The latter is actuated by an arrangement of a connecting rod, crank, and positive-motion cam. One complete revolution of the cam gives the sample a linear motion of 18 in. in each direction and of the following character: $1\frac{1}{2}$ in. with uniformly accelerated motion, 15 in. with uniform motion, $1\frac{1}{2}$ in. with uniformly decelerated motion. The normal rate of operation is from 55 to 60 r.p.m. of the cam, thus giving from 110 to 120 single abrasive strokes per minute. All moving parts are made of duralumin and the crank and cam are counterbalanced on their respective shafts to reduce inertia effects and to insure as smooth operation as possible.

The abradant recommended for general use is 000 emery cloth and a piece 7 in. long and 2 in. wide is fastened to the bottom surface of the holder. The latter is a flat piece of metal, 7 in. long, $2\frac{1}{2}$ in. wide, and about $\frac{1}{8}$ in. thick. It is placed in the machine in a horizontal position with its length parallel to the axis of the roller and resting upon the sample, as it passes over the top of the roller, on what is theoretically a line of contact.

It is prevented from rolling off by a simple device which, at the same time, permits the holder to tip slightly from the horizontal, first to one side and then to the other, according to the direction in which the sample is moving. This

M.I.T. Abrasion Machine



change of position occurs with great rapidity and snap at each reversal of the fabric, and has the important effect of throwing off from the surface of the abradant any abraded material which may have accumulated from the previous stroke.

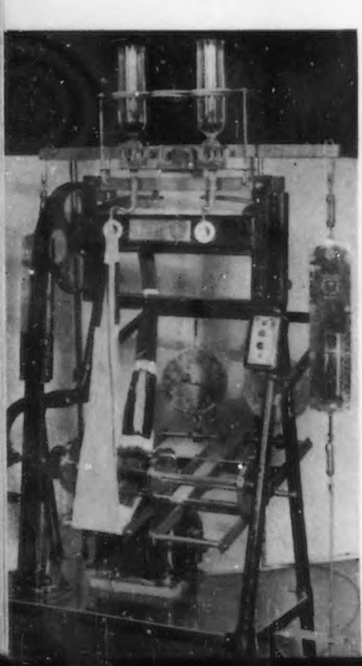
No provision is made for tensioning the emery cloth and great care must be used to see that it lies as smoothly as possible against the holder. The minimum pressure of the abradant on the sample is equal to the weight of the holder, and can be increased to any desired amount by placing additional weights on its upper surface. The tension on the sample is under control and can be of any amount from one pound up.

The diameter of the roller over which the sample is flexed determines the sharpness of the curvature and hence the extent to which the surface of the specimen is opened up to the attack of the abradant. It has been found that a $\frac{1}{4}$ in. diameter roller is satisfactory for light fabrics, a $\frac{1}{2}$ in. diameter roller for those of medium weight, and a 1 in. diameter roller for heavy materials.

An attachment may be added to the machine, the purpose of which is to secure smoother action and better control of abrasion particularly in the case of light fabrics. It consists of two cams, one on each end of the flexing roller. These limit the rotation of this roll to approximately a third of a revolution. They also serve to raise the abradant holder off of the sample on the return stroke and allow it to descend on to the sample on the forward stroke. Thus the material is subjected to abrasion in one direction only and the effect of inertia and stretch, present event with a chain connecting the fabric clamp through the floating weight, is obviated.

No special provision is made for removal of the abraded material from the surface of the specimen. Its motion in a vertical plane with the comparatively high velocity of 165 to 180 ft. per min., the centrifugal force and the rubbing action as it passes over the top of the roller, and its frequent reversals of motion are relied upon to prevent undue accumulation of lint.

It should be noted that this machine gives an unusually large abraded area for examination or further use, namely, 15 in. long and $6\frac{1}{2}$ in. wide. This is sufficient to provide ten strip or four grab test specimens, transverse to the direction of rubbing, for strength determinations if desired. The cutting action of the abradant is across those yarns which lie parallel to the $6\frac{1}{2}$ in. dimension.



The "Perspirator"

The total number of double strokes during the test are recorded on a reset counter. A $\frac{1}{2}$ hp. motor drives the machine through belts, pulleys and a speed-reducing mechanism. Variable speed control is obtained by a rheostat placed in the motor circuit. The machine is designed for attachment to the wall and has the following dimensions, exclusive of the drive: height, 64 in.; width, 40 in.; depth, 9 in.

The "Perspirator":

The "Perspirator" is a special-purpose wearing machine developed in the laboratories of the Industrial By-Products and Research Corp., Philadelphia, Pa., by Charles L. Simon.

The machine was designed originally to reproduce some of the conditions of actual wear under which the materials for the lining of men's coats, vests, and overcoats are used. It recognizes that while the fabric is somewhat firmly held in place by stitching and subjected to abrasion, wrinkling and tension, under conditions of perspiration and warmth, it can also exercise some of its natural elasticity in recovering from the applied forces.

The samples of material to be tested are cut 6 in. long by $4\frac{3}{8}$ in. wide. Eight of them are sewed, using a standard technique, to a base strip of standard cotton drill. This is then threaded through the machine and the ends sewed together forming an endless strip 50 in. long and $4\frac{3}{8}$ in. wide.

The cycle of operations is begun by passing the strip through a porcelain eye $\frac{3}{4}$ in. in inside diameter which crumples the samples widthwise. They then pass between a rubber roll and a motor-driven monel metal roll which not only squeeze the samples, but act as a means of feeding the strip continuously through the machine. The pressure between these rolls is obtained from the pull of a spring balance increased by a lever system and can be regulated. A total pressure of 128 lb. is recommended.

The samples next come in contact with a stationary monel metal bar, $\frac{1}{2}$ in. in diameter and $13\frac{1}{4}$ in. long, which opens up the strip and gives the first abrasion. A spring balance and lever are used to produce and maintain the tension on the strip which can be regulated at any desired amount up to the capacity of the spring balance. The recommended value is $6\frac{1}{2}$ lb. The abrasion effect at this point is produced by an arc of contact between the moving sample and the stationary tension bar.

The samples are next subjected to the more severe abrasive action of four rapidly revolving beater bars. These are monel metal rods $\frac{7}{32}$ in. in diameter, 14 in. long, mounted parallel to each other and turning about a common horizontal axis 800 r.p.m. The beater bars and the tension bar abrade the samples with uniform motion in the direction of their length and across their full width. The friction is of sufficient intensity to produce a temperature practically equal to that of the body.

The strip is passed through the above cycle of events 24 times per minute or at the rate of 100 ft. per min. A test of 1 hr. duration is recommended. For the first 720 cycles (taking $\frac{1}{2}$ hr.) the samples are run dry, and during the remainder of the period are kept thoroughly moistened with the standard acid perspiration solution recommended by the American Association of Textile Chemists and Colorists. At the conclusion of the run the strip is cut off the machine, dried and cut into individual samples.

The machine is designed to test two strips simultaneously, thus producing 16 samples. The abraded area of each sample is 5 by $3\frac{5}{8}$ in. They are rated visually for wearing quality according to a rating scale, which has been worked out by comparing laboratory wear tests with hundreds of worn-out linings removed from garments.

No special provision is made for lint removal, the velocity of the strip being sufficient to keep the samples clear.

The machine is driven by a $\frac{1}{4}$-hp. motor and occupies a floor space 26 in. wide by 19 in. deep. Its over-all height is $52\frac{1}{2}$ in.

The "Perspirator" is also used for determining the resistance to wrinkling of fabrics, and their ability to retain a crease.

If the wrinkleability of a fabric in the direction of the filling, that is, at right angles to the warp, is to be determined, the samples are cut $12\frac{1}{8}$ in. fillingwise and $4\frac{1}{4}$ in. warpwise, and are sewed on the standard cotton drill packing with a $\frac{1}{8}$ in. slack. For men's wear suitings they are previously creased in the middle in the warpwise direction by using a standard pressing technique on a Hoffman Steam Press. Four samples can be mounted on one test strip.

In contrast to the lining tests, the wrinkling tests are run so that the cotton drill backing receives all the abrasion, and the samples under test receive no action except crumpling in the porcelain eye, compression between the monel and rubber covered rollers, and the reopening due to the action of the revolving beater bars and tension bar.

The recommended pressure between rolls is 160 lb., and the strip is put under a tension of 4 lb. No change is made in the speed of the machine but the duration of the test is reduced to 360 cycles (15 min.), and the first trial is always made with the samples in a dry condition. The tests are also run with the samples exposed to a moist or fogged atmosphere.

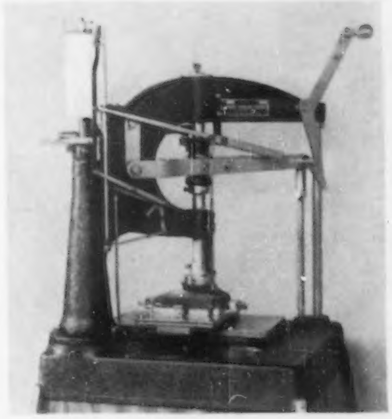
After the tests are completed, the strip is cut off the machine and comparisons for resistance to wrinkling and ability to retain a crease are determined by visual examination.

Shawmut Wear Testing Machine:

The Shawmut wear testing machine is a commercial tester, made by the Shawmut Engineering Co., Boston, Mass., and placed on the market within the past year.

A sample of the material to be tested is cut 6 in. square, placed over a flat bed about $3\frac{1}{2}$ in. square, and held in position by a clamp attached to each edge of the sample. Springs are arranged to apply an initial tension in each of the directions, warp and filling, and to maintain that tension during the test. There is no provision for knowing the amount of the tension.

The abradant is a short cylindrical piece of steel of special grade with unusual hardening qualities. It has an axial hole about $\frac{3}{4}$ in. in diameter for communication with the lint removal system. The abrading surface is the base of the cylinder which is in the form of a ring $2\frac{3}{4}$ in. in outside diameter, and $\frac{3}{4}$ in. in inside diameter. This surface is lapped to a perfect flat, polished to a mirror finish and mounted to operate in exact parallel relation to the bed or platen. Eight shallow radial grooves at 45-deg. intervals extend across the surface.



Shawmut Wear Testing Machine

The wear-producing element is attached to the foot of a hollow spindle which is oscillated through one-eighth of a turn 400 times per minute. The pressure of the abradant on the sample is produced by weighting the spindle through a lever system. Two weights are provided to give pressure of 30 lb. for light fabrics, and 60 lb. for heavy fabrics. The pressure is automatically relieved at intervals of about 5 sec. by a temporary lifting of the abradant off the sample.

The sample bed is moved by cams with uniform speed over a path the general form of which is that of a figure eight. It is arranged so that the abradant passes over all parts of the surface of the sample and in opposite directions during each complete cycle of the motion. One cycle is completed per minute and the abraded area is $3\frac{1}{4}$ in. square.

The debris which results is removed by a suction system operated from a vacuum pump built into the base of a machine, and provision is made to maintain a uniform vacuum. This is connected through the frame of the machine to the hollow spindle, producing a flow of air inward through the radial grooves in the abrading surface.

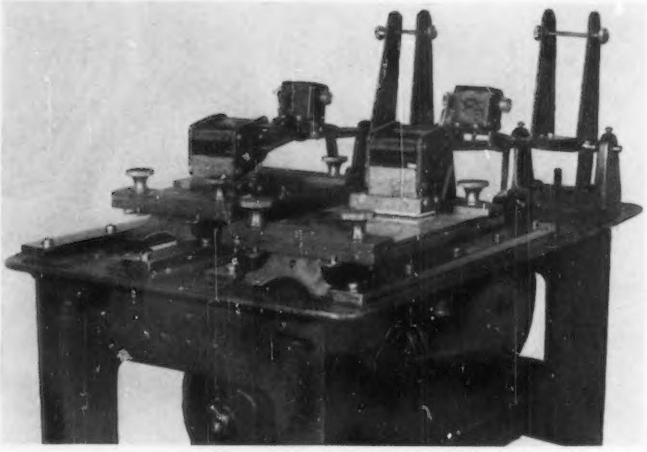
After every 5 or 15 cycles of motion of the sample, that is, at either 5 or 15-min. intervals, the machine automatically measures the thickness of the sample. This is recorded autographically on charts which are good for either a 15 or 60-hr. run. Measurements are always taken at the same spot on the sample and by means of a presser foot, the pressure of which can be regulated. An adjustment is provided whereby the machine will stop automatically when any predetermined thickness has been reached. The calibrations are in decimal parts of an inch and a variation of 0.001 in. shows on the chart as about $\frac{3}{64}$ in.

The machine is entirely self-contained, occupies a floor space of 30 by 30 in., and is mounted on casters so that it can easily be rolled from place to place. A $\frac{1}{2}$ hp. motor which furnishes the entire motor power, the vacuum pump, and the operating cams, are located in the base of the machine. The sample bed or working plane is about 36 in. from the floor, and the maximum over-all height is about 5 ft.

U. S. Testing Co., Inc., Abrasion (Wear Test) Machine:

The United States Testing Co., Inc., Abrasion (Wear Test) Machine is a commercial tester made by the United States Testing Co., Inc., Hoboken, N. J.

In this machine the sample is placed on the flat bed of a carriage which is reciprocated in a horizontal direction under a stationary abradant.



United States Testing Co. Machine

A specimen of the fabric to be tested is cut 4 in. wide and 5¾ in. long. It is placed on the flat bed of the carriage and held in place by clamps fastened to each end. One clamp is stationary, and the other is arranged so as to apply and maintain during the test a spring tension of 8 lb. uniformly across the entire width of the fabric and in the direction of its length.

The abradant generally used is a No. 320 flexible aloxite cloth 4 in. wide, or a piece of fabric of the same type as that being tested. The abradant is placed in the machine in roll form in such a manner that a new section may be brought into position for use by merely pulling it forward. Provision is made for clamping and holding that section under a tension which is applied by hand and of an amount sufficient to remove all wrinkles. It is recommended that the abradant be changed for every new sample and after 5000 double strokes on samples that withstand greater wear than this.

The area of the abradant in contact with the test specimen is 4 by 0.44 in. This is the size of the under surface of a metal shoe over which the abrasive cloth has been stretched. The shoe is held in a fixed position by its attachment to a horizontal arm pivoted at the rear of the machine, thereby permitting the operator to raise the abrasive from the sample for inspection or to insert a new one.

The minimum pressure between the abradant and sample is 33 oz. This may be increased to any higher value by additional weights placed on the arm. A maximum of 88 oz. for the heavy type of fabrics is suggested.

The stroke of the carriage is 3½ in. long and is equidistant on either side of the center of the shoe. Hence, the abraded area is 4 in. wide and 3½ in. long. The direction of rubbing is parallel to the length of the test specimen. The carriage is reciprocated at the rate of 90 double strokes per minute and is operated by a crank and connecting rod mechanism. A reset counter records the total number of double strokes.

No provision is made for lint removal.

Each machine contains two abrading units as described above, and is driven by a ¼-hp. motor. It requires a bench space 12 in. wide and 20 in. deep. Its over-all height is 24 in.

Wyzenbeek Precision Wear Test Meter:

The Precision Wear Test Meter is made by Wyzenbeek and Staff, Inc., Chicago, Ill., and sold by them directly or through agents, of which the New York representative is Alfred Suter, New York City.

The moving element in this machine is a semi-cylindrical cast aluminum drum, with its axis horizontal. It is 12¼ in. long and has two long toothed clamps on its lower edges to hold abrasive material firmly in contact with the drum. Both toothed clamps are operated through a toggle action lever mechanism by a single handle for conveniently placing the abrasive on the drum. The standard abrasive material furnished with the machine is a double layer of stainless steel wire cloth. This surface produces a mild, though very constant abrasive action on the samples to be tested. A thermometer is slid into a socket cast in the aluminum drum to keep a check on temperature conditions of the samples under test. This drum is oscillated by a crank and connecting rod through an angle of approximately 50 deg., thus making the length of the rubbing stroke about 3 in. The rate of oscillation produces 180 single rubs per minute, and the direction of motion is along the length of the sample.

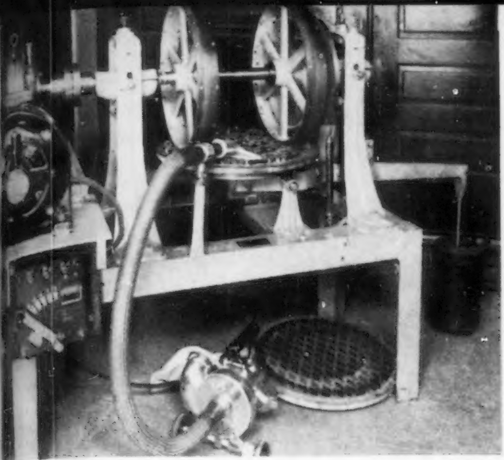
The sample is cut 8 in. long and 2 in. wide. The sample arm has two rubber faced clamps which grip the ends of the specimen, and, by means of a weight and lever system, apply a known and controllable initial tension to it. Any tension may be secured from 2 to 6½ lb. by increments of ½ lb.

The sample, under a definite tension, is lowered until its under surface comes into contact with the stainless steel screen, and the pressure between the two is adjusted to the desired amount. This is accomplished through another weight and lever system designed to give any pressure from 2 to 3½ lb. by increments of ¼ lb. A soft yielding pressure pad, 2 by 2 in. and shaped to fit the curvature of the screen, is used to distribute the pressure evenly over the area of contact and keep the sample in intimate contact with the abrading surface. The abraded area is the same as the area of the pad and the direction of the abrasive action is parallel to the length of the specimen. By raising the sample arm into an upright position, the sample can be brought up into a convenient position for inspection of the abraded area.

The machine contains a vacuum pump whose suction is connected to two slotted pipes. They are so placed that the air drawn into them tends to keep the entire area of the abradant free from lint and other debris, and also serves to maintain a constant temperature of the screen and samples.

In case it is desired to change the character of the abrading surface, the stainless steel screen is simply removed and the surface of the aluminum drum may be covered tautly with emery cloth, cotton duck, a piece of the same kind of fabric that is to be tested, or any other material. There is a totalizing counter which records the number of oscillations of the aluminum drum and an automatic warning bell which can be set to ring at any number of oscillations from 0 to 10,000.

The standard machine has four sample arms so that four specimens can be tested at the same time, but it can be supplied with 3, 6 or 8 specimen holders. It is driven by a ¼-hp. motor, requires a bench or table space 18 by 18 in., for the 4 arm size machine and its over-all height is 26 in.



National Bureau of Standards' Carpet Wear Machine

National Bureau of Standards' Carpet Wear Testing Machine:

A wear testing machine designed especially for the testing of carpets has been developed by the National Bureau of Standards. A complete description of the machine and its use is to be found in the following two papers:

(1) "Carpet Wear Testing Machine," by H. F. Schiefer and A. S. Best, *Journal of Research*, Nat. Bureau Standards, Vol. 6, June, 1931, p. 927, Research Paper No. 315.

(2) "Wear of Carpets," by H. F. Schiefer and R. S. Cleveland, *Journal of Research*, Nat. Bureau Standards, Vol. 12, February, 1934, p. 155, Research Paper No. 640.

A detailed description of its mechanical features is here omitted and replaced with a quotation of the first two paragraphs of the "Abstract" of the first-named paper.

"A machine for testing the resistance to wear of carpets and similar floor coverings when they are subjected to definite wearing forces under controlled conditions has been developed at the National Bureau of Standards. The forces are chosen to produce the bending, slipping, twisting, and compression of the pile which takes place when a carpet is walked upon.

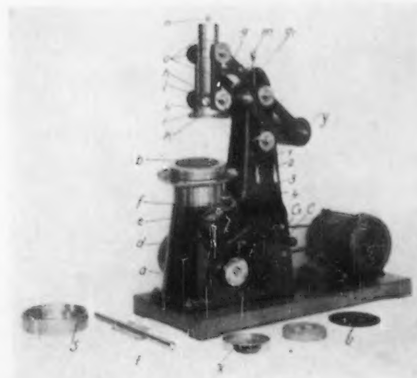
"A circular sample of the carpet to be tested is tacked on a turntable which is brought to bear against two leather-covered wheels. One of the wheels is driven by a motor and in turn drives the turntable. The other wheel is used as a brake to produce slipping of both wheels on the carpet as it rotates. A vacuum cleaner removes the material which is worn off. The wear on the carpet is produced by a downward force, a horizontal stress and a slight twisting motion. They have definite values and may be varied. The rate of wear is evaluated by measuring the change in thickness of the pile of the carpet with a sensitive thickness gage as the test proceeds."

Schopper Abrasion Tester:

The Schopper abrasion tester is a commercial tester made by Louis Schopper, Leipzig, Germany, and sold in the United States by Testing Machines, Inc., New York City.

The abrasive action in this machine is produced by the relative motion of a stationary abradant and a moving sample.

The procedure for mounting the sample in its holder is performed at a work bench by means of equipment specially designed for ease of manipulation. A specimen $4\frac{1}{2}$ in. in diameter is required, which is first tightly clamped around its edge in a ring-shaped holder. Into the ring is screwed a solid piece of metal of such a form as to bulge out the specimen into the form of a very flat cone, approximately $\frac{3}{16}$ in. high and $3\frac{1}{8}$ in. in diameter at the base. This subjects the sample to a tension which is dependent on the amount of extension or bulge of the center of the specimen. A gage is provided whereby this bulge can be measured and reproducible settings can be made. The sample holder is then transferred to the machine and set on a turntable which is the moving element of the device.



Schopper Abrasion Tester

The abradant is the surface of a hardened steel disk, 3 in. in diameter, into which shallow, parallel flutes or corrugations have been cut with a density of about 48 to the inch. The disk is fastened to the lower end of a vertical spindle carried by a counterweighted four-bar linkage which guides the abradant as it is lowered onto or raised from the sample. The pressure of the abradant on the specimen is controlled by the placing of known weights, 500, 1000, 1500 and 2000 g., on the vertical spindle. A special holder is provided, which can be substituted in place of the abrading disk, in which a piece of emery cloth, fabric, or other flat material, about 4 by 6 in., can be fastened and then tensioned.

The motion of the turntable may be described as epicyclic in that it has motion around two axes. Its own axis is tipped slightly to the vertical but is also revolved around a vertical axis. This is necessary because the specimen is in the form of a blunt cone and the abrading surface is flat and horizontal. The net result is that a circular spot, about 3 in. in diameter, is rubbed sixty times per minute. After each two hundred rubs the machine automatically stops, the sample and abradant are thoroughly brushed by hand, and the machine is again started in the reverse direction. A reset counter records the total number of rubs of the sample throughout the duration of the test.

The tester occupies a bench space about 10 by 24 in., and its over-all height is 24 in. It is driven by a $\frac{1}{8}$ hp. motor.

Part II—Problems Involved in Wear Testing

Are the terms "abrasion testing" and "wear testing" to be considered as synonymous? It must be recorded that general usage does not appear to make a distinction between them. In the event, however, that it may seem desirable to establish a line of demarcation, the following suggestions are offered:

Abrasion, derived from the verb "to abrade," very distinctly suggests a "rubbing off." The word "abrasion" as an adjective might properly be applied therefore to those machines or tests in which rubbing is the only or at least the major characteristic.

The term "wear" is believed to be more closely associated with the thought of the conditions surrounding everyday use and service and implies the combined effect of several factors of which abrasion or rubbing is only one. A household or garment fabric may wear out from a variety of causes. Thus, a towel is discarded because it has broken down under the combined influences of abrasion, the application of

tensile forces in a dry and wet state, and washing, drying, and ironing. The lining of a coat is worn out as a result of abrasion, perspiration, dry or wet cleaning, and pressing. It is suggested therefore that "wear" be considered as of broader scope than "abrasion" and be used to apply wherever other important destructive actions, with or without abrasion, are existent or are intentionally introduced by the machine or test method. If the above distinction is observed, most of the machines described in Part I would be called abrasion testers. Simon's "Perspirator" would be one example of a wear tester. In the remainder of this paper, the suggested distinction will be observed.

The instances in which the wear of textile materials occurs are so numerous that interest in the subject is very widespread. The wear or serviceability furnished by the fabrics used for wearing apparel and in the household affects nearly every person in some degree. The wear given by the so-called mechanical fabrics is of special interest to those many manufacturers who use them in their respective products or in the conduct of their manufacturing operations. The interest in the subject of wear testing and the determination of service life is on the increase in both groups with the accentuation furnished by the household and garment fabric users. The manufacturers, with their engineering, research, chemical and testing laboratories and technicians, have been able to accumulate much reliable data regarding the suitability of textiles for their particular uses. However, the ultimate consumer of textiles in the form of dresses, suits, coats, hosiery, underwear, shirts, towels, sheets, blankets, carpets, rugs, draperies, curtains and upholsteries is not well equipped to secure such data for himself and must rely upon the information secured from the seller, manufacturer, commercial testing laboratories, governmental bureaus, textile schools, departments of home economics in the colleges, and those organizations especially representing consumer interests.

Much thought, time and expense have been devoted to the subject of wear testing and the development of wear testing machines, in some cases with the hope of finding a method or machine universally applicable. To ask the question "can a standard wear test, applicable to all cases, be developed" is to answer it; for to anyone who has given thought to the conditions producing wear, the negative answer is perfectly obvious. The elements of wear affecting carpets, for example, differ so greatly from those affecting a man's suit that it is entirely out of the question to consider a like test for each material. Even the fabrics used in the suit itself, the worsted cloth, the rayon lining, the cotton pocketing, are subject to conditions sufficiently different to cast a doubt upon the possibility of a single wear test for them alone.

Hence it would seem that each condition of wear must become a separate problem in itself, that a test must be devised for each particular set of service conditions to which a fabric is subjected. It is along this line that some wear testers have been developed. Simon's "Perspirator" is designed particularly to simulate the conditions to which coat linings are subjected. The Bureau of Standards carpet tester likewise closely duplicates the conditions to which carpets are subjected.

The question is next raised as to how closely a laboratory wear test should duplicate an actual set of service conditions. If it attempts to reproduce all of them, it will certainly require in some instances a complicated machine and procedure. In any case, is not the answer rather to be found in the results of a preliminary but thorough investigation—one which has for its object the determination of the cause or causes of greatest wear? With this information at hand, the wear testing machine should be planned to reproduce only those influences which are accountable for the major portion of the total destructive effect. If, for example, the greatest deterioration comes from a rubbing or frictional cause, then possibly a simple form of abrasion tester will serve adequately to differentiate between the fabrics tested.

There is one important point to be kept in mind and that is the usual purpose of the tests. It is not required that they shall permit the forecasting of the service life of a material in terms of some unit of time. Rather the problem is one of comparison, of determining such facts as will warrant an opinion that one fabric probably will or will not last longer than another. The question to be answered is as to which of two denims, for example, will probably give the longer life when made into a pair of overalls, and not as to how many months a pair of overalls made of either fabric will last. This limitation of purpose tends to reduce the requirements of wear testing and makes the problem one of producing the simplest apparatus which will rate the fabrics in their proper order. The selected procedure may or may not closely duplicate the actual conditions of use.

How is the proper order of wear rating to be established? It has been suggested that this be by proper correlation with service tests, by comparison with records of the actual service given by the fabric or article. This seems quite logical, but it may be in order to point out to those who contemplate its use that there are some difficulties connected with the assembling of reliable data. This is more particularly true of household and garment fabrics than of those used for mechanical purposes where conditions and records of use are under better control. Assume, for example, that the study is one that involves the serviceability of a certain dress material and that it is to be based upon the results of use by many wearers. It is easy to visualize some of the numerous variable conditions which will occur due to differences in the occupations of the wearers, their size and weight, degree of fit, amount and character of perspiration, oiliness of skin, frequency and character of cleansing of the article, and general severity of use. Further, if it should happen that a record were kept by the wearer, it will be exact or inexact only according to that person's own idea as to what constitutes an adequate record of facts.

It is not the intention to minimize the value of service tests, especially those deliberately planned, nor to suggest that complaints regarding unsatisfactory wear brought to the attention of the seller are to be ignored. They are undoubtedly of some value in disclosing major defects and major differences in quality. It does raise the question, however, as to their suitability for the distinction of closer differences, *unless* a representative sample of sufficient size is available to insure that the averages obtained have a suitable degree of reliability.

How may the effects of abrasion be measured? We are here dealing with the problem of finding a means of evaluating the work done upon a textile by a frictional force. Its measurement should yield a quantity proportional to the

effect of the frictional force; in other words the selected measure should be one that is reasonably sensitive and proportional to the work done upon the sample.

Various measures have been suggested of which the important ones are the changes produced in the (1) tensile strength, (2) thickness, (3) weight, (4) surface luster, (5) air permeability, (6) color, (7) character of abraded materials, and (8) appearance of surface. The first six represent properties which it is possible to measure physically, and this is a feature considered to be an advantage by those who prefer to have numerical values to back up their opinions of a fabric. The last two would be determined with the aid of a microscope, and possibly by comparison with established standards, but are of such a character that the personal equation enters to some degree in the formation of an opinion. Which measure should be selected for a particular investigation would primarily be governed by the nature of the service conditions of the cloth which is being tested. If, in actual use, it were the decrease in strength of a fabric that was the important criterion of its serviceability, it would be natural to select the change in strength of the test samples as a suitable means of rating the relative value of the fabrics under consideration.

There are, however, certain limitations to this basic selection of a measure which should be noted. The changes in certain of the properties mentioned above are not always in the same direction nor proportional to the work expended. Some fabrics, for example, first increase in thickness with increasing rubs, and then begin to decrease as the abrasion is continued. This is due to the cutting and breakage of the fibers and the teasing of them out of the yarn, resulting in a rough, fuzzy surface of greater thickness than the original, when measured under like conditions of pressure. Further abrasion finally reaches a point when these fibers become detached from the surface faster than new fibers are raised up and the thickness begins to decrease. Other cloths have such structures or yarns that they load with particles of the abradant and their own detritus. The result is an increase in weight in the early stages of a test, followed later by the anticipated decrease if the abrasive action is continued far enough. The permeability of a fabric to air depends upon the extent to which the test has progressed and the resultant degree of closure of the interstices with the roughening of the surface and with loading. While one fabric at first exhibits a decrease in permeability followed by an increase, another fabric may show a continuous increase from the start. Whereas it is observed that tensile strength almost always decreases with the number of abrasive strokes, it is not always in a manner proportional thereto.

The problems connected with abrasion or wear testing are so numerous that this paper would become of undue length if each were to be properly and fully discussed. It is hoped that the few points presented here will merely emphasize the extent to which care and judgment must be exercised in planning wear or abrasion tests and that even greater judgment must be used in interpreting their results.

Report on Cooperative Tests of Portland Cement Comparative Sample C. R. L. No. 1

EDITOR'S NOTE.—This report from Committee C-1 on Cement has been prepared by the Cement Reference Laboratory which is sponsored by the committee and maintained jointly by the Society and the National Bureau of Standards. Reference is made to the cooperative tests in the 1937 report of Committee C-1, and while the committee has not offered comments pending the collation of replies from laboratories engaged in the test, it is indicated that better agreement among laboratories was obtained than in possibly any other previous cooperative tests. This report on cooperative tests will not be published in the Society *Proceedings*.

THE comparative tests reported herein were made on a sample of cement distributed some months ago by the Cement Reference Laboratory, at the National Bureau of Standards. The tests were intended not only to afford information to the participating laboratories, but also to secure, particularly from participants, such discussion as might indicate whether such comparative tests, of a briefer nature, performed at intervals and reported quickly upon receipt of the various reports, would be advisable and warranted. On that account, the strength test program was more extensive than ordinarily desired and the results were awaited from nearly all of the laboratories. The data were subsequently studied in more detail than would ordinarily be necessary for usual routine procedure in such cases.

The preparation and distribution of the samples and this study of the test results were conducted by the Cement Reference Laboratory at the National Bureau of Standards.

PARTICIPANTS

The names of the participating laboratories are presented in Table I. Emphasis is placed on the fact that the order in which the names appear does not correspond in any way with the order and assigned numbers in the subsequent tabulations.

TEST RESULTS

Fineness.—The results of the fineness tests on the No. 200 sieve are presented in Table II. Table III includes the results of the tests for specific surface made with the Wagner turbidimeter. This latter test was not made in some laboratories because of the absence of the necessary equipment. The procedure followed in making the turbidimeter test was that specified in the Tentative Method of Test for Fineness of Portland Cement by Means of the Turbidimeter (A.S.T.M. Designation: C 115 – 34 T).[1] Attention is called to the fact that these comparative tests have shown that there has been considerable difference in the interpretation of the specifications with regard to the oscillation of the tank when preparing the suspension.

Normal Consistency.—The results of the normal consistency tests using standard Vicat apparatus on the neat cement are shown in Table II. For tests on the mortars, two consistencies were employed by each laboratory, as described below in the paragraph on strength.

[1] *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part I, p. 777 (1935); also 1937 Book of A.S.T.M. Tentative Standards, p. 466.

TABLE I.—COOPERATING LABORATORIES

NOTE.—The order in which the names of the laboratories are presented below does *not* correspond with the numbers assigned to them in the tabulations of the test results.

Laboratory	Location
Department of Public Works—Division of Engineering	Albany, N. Y.
Lehigh Portland Cement Company	Ormrod, Pa.
Pennsylvania-Dixie Cement Corp.	Richard City, Tenn.
North American Cement Co.	Security, Md.
Standard Portland Cement Co.	Painesville, Ohio
Volunteer Portland Cement Co.	Knoxville, Tenn.
Diamond Portland Cement Co.	Middle Branch, Ohio
Ohio State Highway Testing Laboratory	Columbus, Ohio
Pennsylvania-Dixie Cement Corp.	Bath, Pa.
State Road Department of Florida	Gainesville, Fla.
E. L. Conwell and Co.	Philadelphia, Pa.
Detroit Testing Laboratory	Detroit, Mich.
Oklahoma Testing Laboratory	Oklahoma City, Okla.
Louisiana Highway Commission	Baton Rouge, La.
Medusa Portland Cement Co.	York, Pa.
Marquette Cement Manufacturing Co.	Cape Girardeau, Mo.
Universal-Atlas Cement Co.	Buffington, Ind.
Oklahoma State Highway Commission	Oklahoma City, Okla.
Portland Cement Assn.	Chicago, Ill.
Pittsburgh Testing Laboratory	Pittsburgh, Pa.
Marquette Cement Manufacturing Co.	La Salle, Ill.
San Antonio Portland Cement Co.	San Antonio, Tex.
Illinois Division of Highways	Springfield, Ill.
Pennsylvania Department of Highways	Harrisburg, Pa.
Alpha Portland Cement Co.	Martin's Creek, Pa.
Cement Reference Laboratory	Washington, D. C.
Bureau of Public Roads	Washington, D. C.
Northwestern States Portland Cement Co.	Mason City, Iowa
Ash Grove Lime and Portland Cement Co.	Chanute, Kan.
Texas State Highway Laboratory	Austin, Tex.
Arizona State Highway Department	Phoenix, Ariz.
New Mexico State Highway Department	Las Cruces, N. M.
Lone Star Cement Co., Inc.	Hudson, N. Y.
Southwestern Portland Cement Co.	El Paso, Tex.
Riverside Cement Co.	Riverside, Calif.
California Division of Highways	Sacramento, Calif.
Trinity Portland Cement Co.	Fort Worth, Tex.
Trinity Portland Cement Co.	Houston, Tex.
Trinity Portland Cement Co.	Dallas, Tex.
Superior Portland Cement Co.	Seattle, Wash.
California Portland Cement Co.	Colton, Calif.
Water Purification Works	Columbus, Ohio
H. C. Nutting Co.	Cincinnati, Ohio
Perry Testing Laboratory	Detroit, Mich.
Vermont State Highway Laboratory	Montpelier, Vt.

TABLE II.—RESULTS OF FINENESS TESTS ON No. 200 SIEVE AND OF TESTS FOR NORMAL CONSISTENCY.

NOTE.—The fineness tests were determined with the No. 200 sieve by the hand-sieving method in accordance with the procedure described in the Standard Methods of Sampling and Testing Portland Cement (A.S.T.M. Designation: C 77 - 32) of the American Society for Testing Materials, 1936 Book of A.S.T.M. Standards, Part II, p. 9.

Normal consistency was determined in accordance with the procedure described in the Standard Methods C 77 - 32.

Laboratory	Fineness, Residue on No. 200 Sieve, Per Cent	Normal Consistency, Per Cent
No. 1	3.6	23.0
No. 2	1.9	24.0
No. 3	2.8	24.0
No. 4	3.2	23.0
No. 5	3.1	23.5
No. 6	3.5	23.8
No. 7	3.5	23.6
No. 8	...	23.0
No. 9	3.2	23.0
No. 10	3.8	23.2
No. 11	3.1	22.5
No. 12	2.6	23.4
No. 13	3.0	23.0
No. 14	3.6	23.5
No. 15	1.0	24.0
No. 16	4.3	23.5
No. 17	3.0	23.0
No. 18	3.0	23.0
No. 19	2.3	23.5
No. 20	3.6	23.0
No. 21	3.0	24.0
No. 22	5.0	23.5
No. 23	2.0	23.0
No. 24	2.7	23.0
No. 25	3.3	23.0
No. 26	3.9	23.5
No. 27	3.4	23.6
No. 28	3.1	22.5
No. 29	2.9	24.0
No. 30	2.9	23.5
No. 31	4.8	23.5
No. 32	3.2	23.0
No. 33	2.8	24.0
No. 34	2.6	23.0
No. 35	3.0	23.0
No. 36	3.9	22.0
No. 37	5.0	23.0
No. 38	2.9	22.8
No. 39	3.2	23.5
No. 40	2.9	23.0
No. 41	2.8	22.8
No. 42	3.2	23.0
No. 43	3.4	23.5
No. 44	3.0	23.0
No. 45	3.5	23.0
Grand Average	3.2	23.2
High Value	5.0	24.0
Low Value	1.0	22.0
Range in Value	4.0	2.0

DISTRIBUTION OF LABORATORIES ACCORDING TO RANGE OF TEST RESULTS

Variations in Fineness Test Results from Grand Average:	
0.5 per cent [b] and less	31 laboratories
Over 0.5 per cent and less than 1.0 per cent	7 laboratories
Over 1.0 per cent and less than 1.8 per cent	6 laboratories
Range in Normal Consistency Results:	
22.0 to 22.4 per cent	1 laboratory
22.5 to 22.9 per cent	4 laboratories
23.0 to 23.4 per cent	21 laboratories
23.5 to 23.8 per cent	13 laboratories
23.9 to 24.0 per cent	6 laboratories

[b] This percentage is the percentage of the weight of the original sample and is not a percentage of the average sieving value.

Time of Setting.—The results of the time of setting tests, which were made by the Gillmore method, appear in Table IV.

Strength.—Two consistencies were employed by each laboratory in the preparation of the mortars. Mortar *A* contained the amount of mixing water determined in specification manner by the respective laboratory, and the tensile strengths of that mortar are reported in Table V. Mortar *B*, prepared to afford comparisons between laboratories when the amount of mixing water was constant, contained 10.5 per cent water and its strengths are reported in Table VI. In those cases where a laboratory used 10.5 per cent of water for mortar *A*, the specimens reported under mortar *B* are the same specimens as tabulated under mortar *A*.

On each of 3 days, and for both mortars *A* and *B*, there were prepared specimens for test at the ages of 1, 3, 7, and 28 days. Each of the daily strength values reported in the tables is the average of the results of test of three specimens. The individual test results are omitted from the report, but the spread in daily results is shown.

Table VII presents, in convenient form, the percentages by which the average daily strengths and the average strength of each group of nine specimens of a kind, for any one laboratory, varied from the corresponding grand averages for all laboratories. (Note that results of tests on mortar *B* are reported on the left-hand side of Table VII.)

In studying the results of these tests, and as is frequently done in general practice, the individual test results (not shown in the accompanying tables) were tabulated to the nearest 5 lb. The daily averages and the average for each

TABLE III.—RESULTS OF SPECIFIC SURFACE TESTS BY THE WAGNER TURBIDIMETER

NOTE.—Specific surface was determined in accordance with the Tentative Method of Test for Fineness of Portland Cement by Means of the Turbidimeter (A.S.T.M. Designation: C 115-34 T) of the American Society for Testing Materials, *Proceedings*, Am. Soc. Testing Mats., Vol. 35, Part I, p. 777 (1935); also 1937 Book of A.S.T.M. Tentative Standards, p. 466.

Laboratory	Specific Surface, sq. cm. per g.						Method of Oscillation[a]
	Sample from Cans			Sample from Bottles			
	First Test	Second Test	Average	First Test	Second Test	Average	
No. 2..	1720	1720	1720	1680	1700	1690	A
No. 5..	1880	1900	1890	1900	1900	1900	A
No. 9..	1610, 1620	1630	1620	1620, 1630	1630, 1660	1640	A
No. 12..	1720	1730	1720	1750	1730	1740	A
No. 13..	1710	1720	1720	1700	1700	1700	A
No. 14..	1610	1640	1620	1630	1660	1640	C
No. 15..	1660	1650	1660	1650	1660	1660	D
No. 16..	1860	1850	1860	1820	1800	1810	B
No. 17..	1620	1670	1640	1660	1710	1680	A
No. 18..	1790	1810	1800	1780	1810	1800	D
No. 20..	1670	1660	1660	1590	1610	1600	A
No. 21..	1780	1770	1780	1760	1750	1760	A
No. 22..	1720	1710	1720	1670	1670	1670	A
No. 24..	1580, 1600, 1610	1550, 1560, 1570	1580	1320	1340	1330	B
No. 26..	1780, 1770	1790	1780	1660, 1680	1680	1670	A
No. 28..	1710	1700	1700	1710	1730	1720	D
No. 30..	1790	1780	1780	1700	1710	1700	A
No. 31..	1710	1710	1710	1660	1690	1680	A
No. 32..	1650	1660	1660	1700	1710	1700	A
No. 33..	1690, 1720	1700, 1740	1720	1650	1690	1670	A
No. 34..	1690	1710	1700	1710	1710	1710	D
No. 36..	1750	1750	1750	1740	1780	1760	A
No. 38..	1720	1690	1700	1720	1720	1720	A
No. 39..	1720	1720	1720	1700	1700	1700	A
No. 40..	1720, 1720	1720, 1740	1720	1720	1730	1720	B
No. 41..	1660	1630	1650	1580	1650	1620	E
No. 43..	1640	1640	1640	1610	1630	1620	A
No. 45..	1600	1700	1650	1650	1600	1620	A
Grand Average	....	....	1710	....	....	1690	
High Value..	....	....	1890	....	....	1900	
Low Value..	....	....	1580	....	....	1330	
Spread..	....	....	310	....	....	570	

DISTRIBUTION OF LABORATORIES ACCORDING TO RANGE IN TEST RESULTS

	Number of Laboratories	
	Sample from Cans	Sample from Bottles
Variations from Grand Average:		
Not more than 3 per cent	15	18
More than 3 per cent but not more than 5 per cent..	7	5
More than 5 per cent but not more than 8 per cent..	4	3
More than 8 per cent but not more than 13 per cent..	2	1
21 per cent	....	1

[a] The method of oscillation used by the various laboratories as indicated in this column was as follows:
A—Oscillation, 180 deg. from vertical upright position to an upside-down position, standard method.
B—Oscillation, 180 deg. measured between horizontal positions of the tank.
C—Mechanical stirring device used in tank instead of tank oscillation.
D—No information furnished as to tank oscillation.
E—Involves variations in some details from A.S.T.M. Method C 115-34 T.

group of nine individual results also are likewise presented in this report to only the nearest 5 lb., although in the calculations of variations these averages were actually more closely calculated and tabulated.

GENERAL

Some laboratories submitted recording thermometer charts showing storage temperatures, while others reported whether storage temperatures were controlled. The tabulations of

TABLE IV.—RESULTS OF TIME OF SETTING TESTS BY THE GILLMORE METHOD.

NOTE.—The time of setting tests were determined in accordance with the procedure described in the Standard Methods of Sampling and Testing Portland Cement (A.S.T.M. Designation: C 77 - 32) of the American Society for Testing Materials, 1936 Book of A.S.T.M. Standards, Part II, p. 9.

Laboratory	Initial Set		Final Set	
	Hours	Minutes	Hours	Minutes
No. 1[a]	2	45	5	0
No. 2[a]	3	10	5	0
No. 3[a]	3	55	5	50
No. 4[a]	3	35	6	0
No. 5[a]	3	20	5	50
No. 6	4	20	6	30
No. 7	4	0	7	45
No. 8[a]	3	15	5	55
No. 9[a]	3	40	5	5
No. 10	3	20	5	50
No. 11[a]	3	5	4	50
No. 12[a]	3	30	6	15
No. 13	3	30	5	30
No. 14[a]	4	15	7	30
No. 15[a]	3	10	6	50
No. 16[a]	3	5	4	20
No. 17[a]	3	30	5	40
No. 18	3	35	5	55
No. 19	4	0	6	30
No. 20[a]	3	45	5	45
No. 21[a]	4	0	6	0
No. 22[a]	3	50	6	30
No. 23[a]	2	35	3	50
No. 24[a]	3	20	5	30
No. 25[a]	2	40	5	10
No. 26[a]	4	30	6	30
No. 27[a]	2	40	4	20
No. 28[a]	3	45	7	0
No. 29[a]	3	5	5	0
No. 30[a]	2	40	5	35
No. 31[a]	3	0	5	10
No. 32[a]	3	35	6	5
No. 33[a]	5	0	6	0
No. 34[a]	3	30	5	40
No. 35[a]	3	20	5	55
No. 36	4	0	7	15
No. 37[a]	4	20	6	45
No. 38[a]	2	45	4	45
No. 39[a]	3	35	6	25
No. 40[a]	3	10	5	30
No. 41	3	10	5	10
No. 42[a]	3	35	6	0
No. 43[a]	3	10	6	0
No. 44[a]	3	35	5	45
No. 45[a]	2	40	4	55
Grand Average	3	30	5	45
High Value	5	0	7	45
Low Value	2	35	3	50
Spread	2	25	3	55

DISTRIBUTION OF LABORATORIES ACCORDING TO RANGE IN TEST RESULTS

	Number of Laboratories
Variations in Initial Setting Time from Grand Average:	
Not more than 15 min.	18
More than 15 min. but not more than 30 min.	15
More than 30 min. but not more than 45 min.	3
More than 45 min. but not more than 1 hr.	8
1½ hr.	1
Variations in Final Setting Time from Grand Average:	
Not more than 30 min.	20
More than 30 min. but not more than 1 hr.	17
More than 1 hr. but not more than 1½ hr.	5
More than 1½ hr. but not more than 2 hrs.	3

[a] These laboratories reported the use of thermostatically controlled moist air storage equipment.

the results for the time-of-setting and the strength tests indicate those laboratories which used temperature regulated moist cabinets and tanks, although they imply no statement as to the relative performance of the various reported temperature controls. Maximum and minimum temperatures are not included.

TABLE V.—TENSILE STRENGTH TESTS ON MORTAR A.

NOTE.—The tensile strength tests were made in accordance with the procedure described in the Standard Methods of Sampling and Testing Portland Cement (A. S. T. M. Designation: C 77-32) of the American Society for Testing Materials, 1936 Book of A. S. T. M. Standards, Part II, p. 9.
The percentage of water used in preparing the specimens was calculated from the Vicat tests made in the respective laboratories.

One Day Tensile Strength Tests

Laboratory	Average Tensile Strengths lb. per sq. in.				Spread in Tensile Strength lb. per sq. in.			
	First Day (3 Specimens)	Second Day (3 Specimens)	Third Day (3 Specimens)	All 9 Specimens	First Day	Second Day	Third Day	Average of 3 Days
No. 1[a]	145	140	140	140	10	30	20	20
No. 2[a]	150	160	160	155	15	15	15	15
No. 3[a]	110	115	120	115	15	15	25	20
No 4[a]	155	150	155	155	5	10	10	10
No. 5[a]	115	125	130	125	25	30	15	25
No. 6	160	150	165	155	15	5	10	10
No. 7	165	170	185	175	15	25	25	20
No. 8[a]	145	155	150	150	15	10	10	10
No. 9[a]	150	160	150	155	20	15	15	15
No. 10	135	145	145	140	10	20	10	15
No. 11[a]	180	175	165	175	40	10	35	30
No. 12[a]	145	145	160	150	5	20	5	10
No. 13	145	160	170	160	20	15	20	20
No. 14[a]	180	180	175	180	5	5	10	5
No. 15[a]	135	145	135	140	10	15	15	15
No. 16[a]	170	170	165	170	20	15	5	15
No. 17[a]	145	135	140	140	15	20	15	15
No. 18	145	150	155	150	0	20	5	10
No. 19[b]	155	150	135	145	10	15	25	15
No. 20[a]	155	155	155	155	10	20	20	15
No. 21[a]	160	160	160	160	15	20	0	10
No. 22[a]	165	145	140	150	50	40	5	30
No. 23[a]	180	180	190	185	10	15	15	15
No. 24[a]	150	145	150	150	25	20	5	15
No. 25[a]	155	135	140	145	5	5	20	10
No. 26[a]	140	135	140	140	20	10	10	15
No. 27[a]	140	130	145	140	5	15	10	10
No. 28[a]	145	160	160	155	10	15	35	20
No. 29[a]	130	145	115	130	5	15	5	10
No. 30[a]	145	150	150	150	5	0	10	5
No. 31[a]	150	160	150	155	10	10	5	10
No. 32[a]	175	170	165	170	20	5	0	10
No. 33[a]	150	150	150	150	0	10	5	5
No. 34[a]	145	140	135	140	10	10	5	10
No. 35[a]	165	150	165	160	10	30	10	15
No. 36	135	135	145	140	15	10	15	15
No. 37[a]	125	125	115	120	10	5	10	10
No. 38[a]	175	165	175	175	15	15	15	15
No. 39[a]	150	160	165	155	15	25	10	15
No. 40[a]	140	150	140	140	5	20	25	15
No. 41	145	145	145	145	15	25	15	20
No. 42[a]	150	145	145	145	25	15	5	15
No. 43[a]	175	135	165	160	40	20	30	30
No. 44[a]	170	185	190	180	30	20	20	25
No. 45[a]	145	150	145	145	25	35	30	30
Grand Average	....	....	....	150	....	....	....	15

Three Day Tensile Strength Tests

Laboratory	Average Tensile Strengths lb. per sq. in.				Spread in Tensile Strength lb. per sq. in.			
	First Day (3 Specimens)	Second Day (3 Specimens)	Third Day (3 Specimens)	All 9 Specimens	First Day	Second Day	Third Day	Average of 3 Days
No. 1[a]	280	255	275	270	20	20	25	20
No. 2[a]	280	290	290	290	15	15	15	15
No. 3[a]	250	255	260	255	15	10	5	10
No 4[a]	245	255	255	250	25	5	15	15
No. 5[a]	255	275	270	265	40	20	25	30
No. 6	245	255	280	260	25	25	25	25
No. 7	320	310	300	310	5	25	35	20
No. 8[a]	255	245	240	245	35	10	5	15
No. 9[a]	260	260	265	260	5	20	10	10
No. 10	245	225	245	240	10	25	25	20
No. 11[a]	305	275	295	295	35	10	20	20
No. 12[a]	260	250	265	260	15	10	10	10
No. 13	285	280	265	275	30	20	10	20
No. 14[a]	265	260	265	265	20	35	30	30
No. 15[a]	270	265	265	265	50	40	15	35
No. 16[a]	270	270	235	260	20	5	50	25
No. 17[a]	275	255	265	265	10	20	10	15
No. 18	285	280	280	280	15	10	35	20
No. 19[b]	250	245	265	255	20	20	30	25
No. 20[a]	300	295	290	295	35	20	20	25
No. 21[a]	295	295	290	295	10	25	35	25
No. 22[a]	270	280	270	270	40	30	15	30
No. 23[a]	335	325	315	325	15	10	20	15
No. 24[a]	245	270	250	255	25	20	25	25
No. 25[a]	265	265	270	265	30	10	45	30
No. 26[a]	270	260	250	260	20	15	35	25
No. 27[a]	240	265	235	245	15	25	50	30
No. 28[a]	290	290	275	285	10	20	25	20
No. 29[a]	235	240	235	235	25	20	10	20
No. 30[a]	270	275	275	270	5	5	0	5
No. 31[a]	280	295	275	285	20	10	25	20
No. 32[a]	310	310	300	305	40	25	35	35
No. 33[a]	295	290	285	290	20	20	10	15
No. 34[a]	255	250	245	250	15	5	10	10
No. 35[a]	275	265	265	270	20	40	30	30
No. 36	300	285	280	285	40	15	30	30
No. 37[a]	240	275	245	255	40	25	45	35
No. 38[a]	265	295	295	285	15	25	10	15
No. 39[a]	265	280	280	275	15	25	25	20
No. 40[a]	260	265	265	265	40	20	20	25
No. 41	270	275	255	265	10	10	15	10
No. 42[a]	305	270	255	275	15	0	15	10
No. 43[a]	280	235	255	255	70	55	30	50
No. 44[a]	290	305	310	300	30	10	45	30
No. 45[a]	290	280	290	285	15	20	30	20
Grand Average	....	....	....	270	....	....	....	20

Seven Day Tensile Strength Tests

Laboratory	Average Tensile Strengths lb. per sq. in.				Spread in Tensile Strength lb. per sq. in.			
	First Day (3 Specimens)	Second Day (3 Specimens)	Third Day (3 Specimens)	All 9 Specimens	First Day	Second Day	Third Day	Average of 3 Days
No. 1[a]	365	365	374	370	25	35	20	25
No. 2[a]	410	400	395	400	10	5	25	15
No. 3[a]	345	345	350	345	10	20	25	20
No. 4[a]	335	340	335	335	10	25	30	20
No. 5[a]	355	360	355	355	20	40	10	25
No. 6	350	335	350	345	20	15	5	15
No. 7	375	405	430	405	15	50	25	30
No. 8[a]	335	345	345	340	15	30	35	25
No. 9[a]	390	380	380	385	20	15	25	20
No. 10	360	355	350	355	45	20	20	30
No. 11[a]	390	365	365	375	20	15	25	20
No. 12[a]	345	350	365	355	65	40	45	50
No. 13	350	370	345	355	10	15	10	10
No. 14[a]	360	345	350	350	45	0	5	15
No 15[a]	360	360	365	360	30	40	5	25
No. 16[a]	340	365	345	350	60	35	10	35
No. 17[a]	380	360	375	375	30	20	40	30
No. 18	360	355	355	355	35	20	35	30
No. 19[b]	340	325	335	335	15	30	15	20
No. 20[a]	385	390	365	380	60	40	25	40
No. 21[a]	405	365	405	390	40	40	55	45
No. 22[a]	340	360	335	345	50	50	30	45
No. 23[a]	425	400	410	410	15	30	20	20
No. 24[a]	310	320	325	315	5	30	25	20
No. 25[a]	360	345	375	360	25	25	10	20
No. 26[a]	345	355	360	355	20	30	5	20
No. 27[a]	360	370	345	360	50	25	25	35
No. 28[a]	370	360	365	365	40	55	95	65
No. 29[a]	315	315	315	315	15	20	20	20
No. 30[a]	370	375	380	375	5	5	10	5
No. 31[a]	375	385	365	375	10	20	25	20
No. 32[a]	400	390	390	395	40	30	60	45
No. 33[a]	390	390	385	390	40	40	30	35
No. 34[a]	335	340	335	335	25	20	15	20
No. 35[a]	360	370	365	365	20	30	40	30
No. 36	345	345	390	360	45	35	15	30
No. 37[a]	365	360	385	370	40	40	45	40
No. 38[a]	405	395	390	395	15	15	10	15
No. 39[a]	380	390	375	380	45	25	30	35
No. 40[a]	350	360	365	360	20	20	15	20
No. 41	370	370	360	365	45	20	10	25
No. 42[a]	360	370	380	370	60	5	40	35
No. 43[a]	390	370	355	375	35	80	60	60
No. 44[a]	395	405	365	385	60	30	50	45
No. 45[a]	375	355	375	370	30	30	40	35
Grand Average	....	....	....	365	....	....	....	30

Twenty-eight Day Tensile Strength Tests

Laboratory	Average Tensile Strengths lb. per sq. in.				Spread in Tensile Strength lb. per sq. in.			
	First Day (3 Specimens)	Second Day (3 Specimens)	Third Day (3 Specimens)	All 9 Specimens	First Day	Second Day	Third Day	Average of 3 Days
No. 1[a]	470	490	485	480	25	25	35	30
No. 2[a]	490	475	475	480	35	15	10	20
No. 3[a]	470	475	460	470	15	40	35	30
No. 4[a]	455	465	460	460	60	40	25	40
No. 5[a]	430	425	435	430	35	30	5	25
No. 6	380	415	405	400	5	30	30	20
No. 7	515	525	495	510	35	5	25	20
No. 8[a]	470	480	470	475	50	15	55	40
No. 9[a]	470	470	470	470	25	20	15	20
No. 10	410	410	420	415	10	15	10	10
No. 11[a]	495	470	495	485	20	15	20	20
No. 12[a]	490	470	480	480	45	25	50	40
No. 13	445	435	435	440	50	40	10	35
No. 14[a]	455	465	455	455	35	35	10	25
No 15[a]	520	505	515	515	45	55	45	50
No. 16[a]	415	450	435	435	45	80	55	60
No. 17[a]	490	190	490	490	25	25	40	30
No. 18	440	435	430	435	15	10	5	10
No. 19[b]	430	470	475	460	25	30	45	35
No. 20[a]	520	490	515	510	55	65	30	50
No. 21[a]	465	485	480	475	40	60	60	55
No. 22[a]	450	465	490	470	0	45	20	20
No. 23[a]	490	510	500	500	20	25	40	30
No. 24[a]	410	415	440	420	25	30	45	35
No. 25[a]	480	475	465	475	35	30	20	30
No. 26[a]	445	470	455	455	15	35	15	20
No. 27[a]	450	460	460	455	20	15	20	20
No. 28[a]	490	475	485	480	70	60	25	50
No. 29[a]	445	440	405	430	15	20	15	15
No. 30[a]	500	480	505	495	35	40	30	35
No. 31[a]	450	470	495	470	35	40	30	35
No. 32[a]	540	540	520	535	40	60	40	45
No. 33[a]	520	505	520	515	0	20	20	20
No. 34[a]	465	460	455	460	20	20	30	25
No. 35[a]	420	440	445	435	50	50	50	55
No. 36	450	460	495	470	50	45	25	40
No. 37[a]	455	465	490	470	40	60	30	45
No. 38[a]	495	490	480	485	30	5	45	25
No. 39[a]	465	465	470	465	50	60	75	60
No. 40[a]	445	450	450	450	30	30	25	30
No. 41	485	465	460	470	65	65	25	50
No. 42[a]	420	465	450	445	25	70	25	40
No. 43[a]	545	520	500	520	20	40	25	30
No. 44[a]	440	425	490	450	35	5	20	20
No. 45[a]	460	485	500	480	90	35	40	55
Grand Average	....	....	....	470	....	....	....	35

[a] These laboratories reported the use of thermostatically controlled moist air storage equipment.
[b] These laboratories reported the use of thermostatically controlled water storage equipment.
[c] These laboratories reported the use of both thermostatically controlled moist air equipment and thermostatically controlled water storage equipment.

TABLE VI.—TENSILE STRENGTH TESTS ON MORTAR B.

NOTE.—The tensile strength tests were made in accordance with the procedure described in the Standard Methods of Sampling and Testing Portland Cement (A. S. T. M. Designation: C 77 - 32) of the American Society for Testing Materials, 1936 Book of A. S. T. M. Standards, Part II, p. 9.
The percentage of water used in preparation of the specimens was constant at 10.5 per cent.

Laboratory	One Day Tensile Strength Tests								Three Day Tensile Strength Tests							
	Average Tensile Strengths lb. per sq. in.				Spread in Tensile Strength lb. per sq. in.				Average Tensile Strengths lb. per sq. in.				Spread in Tensile Strength lb. per sq. in.			
	First Day (3 Specimens)	Second Day (3 Specimens)	Third Day (3 Specimens)	All 9 Specimens	First Day	Second Day	Third Day	Average of 3 Days	First Day (3 Specimens)	Second Day (3 Specimens)	Third Day (3 Specimens)	All 9 Specimens	First Day	Second Day	Third Day	Average of 3 Days
No. 1[c]	135	130	135	130	5	15	15	10	250	255	250	250	20	25	25	25
No. 2[c]	150	160	160	165	15	15	15	15	280	290	290	290	15	15	15	15
No. 3[c]	110	115	120	115	15	15	25	20	250	255	260	255	15	10	5	10
No. 4[c]	150	150	145	150	15	15	10	15	230	250	245	240	15	25	10	15
No. 5[c]	110	120	130	120	40	10	5	20	255	270	265	265	30	15	15	20
No. 6	160	150	155	155	15	5	10	10	245	255	280	260	25	25	25	25
No. 7	165	170	185	175	15	25	25	20	320	310	300	310	5	25	35	20
No. 8[c]	140	145	160	150	10	10	15	10	245	255	280	260	20	35	20	25
No. 9[c]	125	130	130	130	5	10	10	10	255	250	250	250	10	15	20	15
No. 10	140	130	140	140	20	20	20	20	260	230	245	245	30	20	15	20
No. 11[c]	180	180	185	180	40	10	20	25	270	270	280	275	5	15	20	15
No. 12[c]	145	135	140	140	20	20	10	15	245	255	245	250	30	25	5	20
No. 13	150	165	180	165	25	10	30	20	270	280	270	270	20	15	10	15
No. 14[c]	170	165	165	165	10	15	5	10	260	260	255	255	25	30	10	20
No. 15[c]	135	145	135	140	10	15	15	15	270	265	265	265	50	40	15	35
No. 16[c]	155	155	160	155	25	45	30	35	270	270	255	265	35	35	20	30
No. 17[c]	135	130	130	130	5	10	5	5	240	250	280	255	30	15	15	20
No. 18	150	145	155	150	20	20	5	15	280	250	265	265	15	25	5	15
No. 19[b]	155	140	140	145	25	30	0	20	260	270	270	265	40	35	35	35
No. 20[c]	135	135	145	140	25	0	10	10	290	280	275	280	35	10	35	25
No. 21[c]	160	160	160	160	15	20	0	10	295	295	290	295	10	25	35	25
No. 22[c]	165	155	150	160	45	25	5	25	270	280	280	280	25	15	45	30
No. 23[a]	175	170	170	170	15	15	15	15	290	295	295	295	5	15	40	20
No. 24[c]	110	125	135	125	10	25	40	25	250	250	235	245	5	10	0	5
No. 25[c]	155	145	140	145	10	15	5	10	265	260	245	255	5	40	35	25
No. 26[c]	135	135	135	135	10	15	15	15	255	255	245	250	20	20	20	20
No. 27[c]	130	120	140	130	20	10	5	10	260	260	260	260	30	25	50	35
No. 28[c]	155	155	145	150	10	20	10	15	275	270	255	270	30	15	10	20
No. 29[c]	130	145	115	130	5	15	5	10	235	240	235	235	25	20	10	20
No. 30[c]	140	140	140	140	5	5	5	5	255	265	265	260	5	10	10	10
No. 31[c]	160	155	155	155	10	0	10	5	275	270	265	270	10	20	30	20
No. 32[c]	160	160	150	155	20	30	5	20	295	290	280	290	30	35	25	30
No. 33[c]	150	150	150	150	0	10	5	5	295	290	285	290	20	20	10	5
No. 34[c]	140	130	130	135	5	10	10	10	250	245	240	245	10	10	15	10
No. 35[c]	145	145	150	150	30	10	30	25	265	250	265	260	10	20	40	25
No. 36	110	145	145	130	60	5	5	25	260	270	270	270	5	35	10	15
No. 37[a]	120	135	140	130	20	20	20	20	265	290	235	265	40	35	30	35
No. 38[c]	160	155	160	160	15	20	5	15	265	280	285	275	45	15	25	30
No. 39[c]	160	155	160	160	10	10	5	10	270	265	290	275	30	15	5	15
No. 40[a]	135	145	140	140	5	10	10	10	265	260	260	260	25	20	20	20
No. 41	135	135	130	135	10	10	15	10	270	265	255	265	10	20	0	10
No. 42[c]	155	145	140	145	10	0	5	5	275	300	265	280	10	20	15	15
No. 43[c]	160	130	160	150	35	20	25	25	250	225	210	230	35	40	40	40
No. 44[c]	165	165	185	170	15	20	25	20	265	280	305	285	5	25	50	25
No. 45[c]	165	160	150	155	15	20	15	15	275	290	280	280	20	30	45	30
Grand Average	....	....	....	145	....	....	....	15	....	....	....	265	....	....	....	20

Laboratory	Seven Day Tensile Strength Tests								Twenty-eight Day Tensile Strength Tests							
No. 1[c]	360	350	360	355	30	25	25	25	470	475	470	470	15	35	20	25
No. 2[c]	410	400	395	400	10	5	25	15	490	475	475	480	35	15	10	20
No. 3[c]	345	345	350	345	10	20	25	20	470	475	560	470	15	40	35	30
No. 4[c]	325	330	340	330	20	25	35	25	450	440	445	445	50	55	20	40
No. 5[c]	350	355	355	355	30	10	25	20	430	440	435	435	20	5	25	15
No. 6	350	335	350	345	20	15	5	15	380	415	405	400	5	30	30	20
No. 7	375	405	430	405	15	50	25	30	515	425	495	510	35	5	25	20
No. 8[c]	350	335	335	340	35	45	15	30	470	495	475	480	40	45	10	30
No. 9[c]	360	360	350	355	15	25	10	15	435	435	440	435	10	25	10	15
No. 10	340	355	345	345	30	35	15	25	395	400	410	400	10	25	5	15
No. 11[c]	365	360	360	360	10	15	20	15	480	460	490	475	20	5	20	15
No. 12[c]	365	360	370	365	30	30	45	35	460	465	475	465	10	50	45	35
No. 13	335	350	355	345	10	20	15	15	435	435	455	440	20	20	20	20
No. 14[c]	330	340	340	340	25	15	15	20	405	385	395	395	10	15	20	15
No. 15[c]	360	360	365	360	30	40	5	25	520	505	515	515	45	55	45	50
No. 16[c]	340	355	330	340	10	50	15	25	455	430	455	445	85	40	95	75
No. 17[c]	365	375	370	370	25	30	45	35	465	495	495	485	45	40	50	45
No. 18	350	340	345	345	25	15	20	20	435	450	435	440	20	10	10	15
No. 19[b]	335	335	345	340	10	25	20	20	470	440	440	450	55	45	50	50
No. 20[c]	375	375	355	365	40	10	30	25	520	520	500	515	60	20	70	50
No. 21[c]	405	365	405	390	40	40	55	45	465	480	480	475	40	60	60	55
No. 22[c]	350	355	350	350	65	30	20	40	450	480	490	475	20	55	55	45
No. 23[a]	380	385	365	380	40	15	30	30	520	510	490	510	10	30	20	20
No. 24[c]	305	320	310	310	30	30	25	30	445	445	420	440	10	20	35	20
No. 25[c]	350	355	360	355	10	45	50	35	460	440	490	465	30	10	15	20
No. 26[c]	350	355	355	355	20	20	15	20	450	455	455	455	40	10	35	30
No. 27[c]	320	330	330	325	30	30	40	35	490	460	460	470	15	25	20	20
No. 28[c]	370	360	345	360	20	45	35	35	470	480	480	475	65	40	10	40
No. 29[c]	315	315	315	315	15	20	20	20	440	440	405	430	15	20	15	15
No. 30[c]	360	365	370	365	10	10	5	10	470	475	480	475	15	10	30	20
No. 31[c]	370	350	380	370	45	35	20	35	465	470	480	475	40	40	50	45
No. 32[c]	390	390	380	390	35	25	40	35	520	525	515	520	25	45	40	35
No. 33[c]	390	390	385	390	40	40	30	35	520	505	520	515	0	40	20	20
No. 34[c]	330	330	330	330	25	30	20	25	455	455	445	450	10	20	10	15
No. 35[c]	335	345	365	350	40	30	30	35	475	465	450	460	30	40	80	50
No. 36	370	370	375	370	40	15	20	25	460	465	455	460	25	75	45	50
No. 37[a]	360	350	375	360	20	80	70	55	470	480	465	470	25	50	55	45
No. 38[c]	370	380	370	375	10	35	15	20	455	485	500	480	10	10	25	15
No. 39[c]	360	390	390	380	30	15	45	30	455	490	425	455	40	60	80	60
No. 40[a]	350	350	350	350	20	20	5	15	440	440	450	445	20	20	20	20
No. 41	365	350	345	355	40	35	30	35	480	445	460	460	35	15	35	30
No. 42[c]	340	340	335	340	25	15	45	30	455	425	450	445	70	40	60	55
No. 43[c]	400	370	400	390	65	20	45	45	510	480	495	495	75	35	55	55
No. 44[c]	375	370	385	375	25	50	10	30	450	455	520	475	80	35	15	45
No. 45[c]	360	400	370	375	20	30	35	30	520	530	520	520	30	85	40	50
Grand Average	....	....	....	360	....	....	....	25	....	....	....	465	....	....	....	35

[a] These laboratories reported the use of thermostatically controlled moist air storage equipment.
[b] These laboratories reported the use of thermostatically controlled water storage equipment.
[c] These laboratories reported the use of both thermostatically controlled moist air equipment and thermostatically controlled water storage equipment.

TABLE VII.—PERCENTAGE VARIATION OF DAILY TENSILE STRENGTH RESULTS FROM THE GRAND AVERAGE.

Note.—The "+" sign indicates that the results were greater than the grand average. The "−" sign indicates that the results were less than the grand average.

Percentage Variations in One Day Tensile Strength Tests

Laboratory	MORTAR B Percentage of Water Constant 10.5 Per Cent				MORTAR A Percentage of Water Calculated from Vicat Test Made in Respective Laboratory				
	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens	Water, Per Cent	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens
No. 1[c]	− 8.2	−12.3	− 8.2	− 9.6	10.3	− 4.6	− 7.3	− 7.3	− 6.0
No. 2[cd]	+ 4.1	+ 8.2	+ 8.2	+ 6.8	10.5	+ 0.7	+ 4.6	+ 4.6	+ 3.3
No. 3[cd]	−23.3	−21.9	−17.8	−21.2	10.5	−25.8	−24.5	−20.5	−23.8
No. 4[c]	+ 1.4	+ 4.1	0	+ 2.1	10.3	+ 2.0	− 0.7	+ 2.0	+ 1.3
No. 5[c]	−24.7	−16.4	−12.3	−17.8	10.4	−24.5	−17.9	−13.9	−18.5
No. 6[d]	+ 8.2	+ 4.1	+ 5.5	+ 6.2	10.5	+ 4.6	+ 0.7	+ 2.0	+ 2.6
No. 7[d]	+12.3	+15.1	+26.0	+18.5	10.5	+ 8.6	+11.3	+21.8	+14.6
No. 8[c]	− 4.1	− 1.4	+11.0	− 2.1	10.3	− 4.6	+ 2.0	− 0.7	− 1.3
No. 9[c]	−13.7	−11.0	−11.0	−11.6	10.3	+ 0.7	+ 4.6	+ 0.7	+ 2.0
No. 10	− 4.1	− 9.6	− 2.7	− 5.5	10.3	−11.3	− 3.3	− 4.6	− 6.6
No. 11[c]	+21.9	+23.3	+26.0	+24.0	10.2	+17.9	+16.6	+ 8.6	+14.6
No. 12[c]	− 1.4	− 6.8	− 4.1	− 4.1	10.4	− 3.3	− 3.3	+ 4.6	− 1.3
No. 13	+ 1.4	+12.3	+21.9	+11.6	10.3	− 4.6	+ 4.6	+12.6	+ 4.6
No. 14[c]	+16.4	+13.7	+12.3	+14.4	10.4	+20.5	+17.9	+15.2	+17.9
No. 15[cd]	− 6.8	− 1.4	− 6.8	− 4.8	10.5	− 9.9	− 4.6	− 9.9	− 7.9
No. 16[c]	+ 5.5	+ 5.5	+ 9.6	+ 6.8	10.4	+12.6	+13.9	+ 9.9	+11.9
No. 17[c]	− 8.2	−11.0	− 9.6	− 9.6	10.3	− 4.6	−11.3	− 8.6	− 8.6
No. 18	+ 1.4	− 1.4	+ 5.5	+ 1.4	10.3	− 4.6	+ 0.7	+ 2.0	− 0.7
No. 19[b]	+ 5.5	− 2.7	− 4.1	0	10.4	+ 2.0	− 0.7	− 9.9	− 2.6
No. 20[c]	− 8.2	− 8.2	− 1.4	− 5.5	10.3	+ 2.0	+ 2.0	+ 3.3	+ 2.0
No. 21[cd]	+ 9.6	+ 9.6	+ 9.6	+ 9.6	10.5	+ 6.0	+ 6.0	+ 6.0	+ 6.0
No. 22[c]	+13.7	+ 6.8	+ 4.1	+ 8.2	10.4	+ 8.6	− 4.6	− 6.0	− 1.3
No. 23[a]	+19.2	+17.8	+17.8	+17.8	10.3	+20.5	+20.5	+25.8	+21.8
No. 24[c]	−26.0	−13.7	− 8.2	−15.8	10.3	+ 0.7	− 3.3	+ 0.7	− 0.7
No. 25[c]	+ 5.5	− 1.4	− 5.5	0	10.3	+ 3.3	− 9.9	− 7.3	− 4.6
No. 26[c]	− 8.2	− 8.2	− 8.2	− 8.9	10.4	− 7.3	−11.3	− 7.3	− 8.6
No. 27[c]	−12.3	−17.8	− 2.7	−11.0	10.4	− 6.0	−13.9	− 4.6	− 8.6
No. 28[c]	+ 5.5	+ 5.5	− 1.4	+ 3.4	10.2	− 4.6	+ 4.6	+ 7.3	+ 2.6
No. 29[cd]	− 9.6	− 1.4	−20.6	−10.3	10.5	−12.6	− 5.3	−23.2	−13.2
No. 30[c]	− 5.5	− 2.7	− 2.7	− 3.4	10.4	− 3.3	− 0.7	− 0.7	− 1.3
No. 31[c]	+ 8.2	+ 5.5	+ 6.8	+ 7.5	10.4	+ 0.7	+ 6.0	+ 0.7	+ 2.0
No. 32[c]	+ 9.6	+11.0	+ 1.4	+ 7.5	10.3	+15.2	+13.9	+ 8.6	+12.6
No. 33[cd]	+ 2.7	+ 2.7	+ 1.4	+ 2.1	10.5	− 0.7	− 0.7	− 2.0	− 1.3
No. 34[c]	− 5.5	−11.0	−11.0	− 8.9	10.3	− 3.3	− 7.3	− 9.9	− 6.6
No. 35[c]	0	0	+ 2.7	+ 1.4	10.3	+ 9.9	− 0.7	+ 8.6	+ 6.0
No. 36	−24.7	− 1.4	− 1.4	− 9.6	10.2	− 9.9	− 9.9	− 3.3	− 7.3
No. 37[a]	−17.8	− 8.2	− 5.5	−10.3	10.3	−16.6	−16.6	−24.5	−19.2
No. 38[c]	+ 9.6	+ 6.8	+ 8.2	+ 8.2	10.3	+16.6	+ 9.9	+16.6	+14.6
No. 39[c]	+ 9.6	+ 5.5	+11.0	+ 8.9	10.4	− 2.0	+ 4.6	+ 3.6	+ 2.0
No. 40[a]	− 6.8	− 1.4	− 4.1	− 4.1	10.3	− 8.6	− 2.0	− 8.6	− 6.0
No. 41	− 8.2	− 6.8	−11.0	− 8.2	10.3	− 3.3	− 3.3	− 4.6	− 3.3
No. 42[c]	+ 5.5	− 1.4	− 5.5	0	10.3	− 0.7	− 4.6	− 3.3	− 2.6
No. 43[c]	+11.0	−11.0	+11.0	+ 3.4	10.4	+15.2	− 9.9	+ 8.6	+ 4.6
No. 44[c]	+12.3	+12.3	+26.0	+17.1	10.3	+11.3	+21.8	+25.8	+19.9
No. 45[c]	+12.3	+ 8.2	+ 1.4	+ 7.5	10.3	− 3.3	− 2.0	− 3.3	− 2.6
Average	9.8	8.2	8.7	8.4	10.4	8.0	7.7	8.4	7.4

Percentage Variations in Three Day Tensile Strength Tests

Laboratory	MORTAR B Percentage of Water Constant 10.5 Per Cent				MORTAR A Percentage of Water Calculated from Vicat Test Made in Respective Laboratory				
	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens	Water, Per Cent	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens
No. 1[c]	− 6.0	− 4.5	− 5.3	− 5.3	10.3	+ 2.2	− 5.9	+ 0.7	− 0.7
No. 2[cd]	+ 6.0	+ 9.8	+ 9.0	+ 8.3	10.5	+ 3.7	+ 7.4	+ 6.6	+ 5.9
No. 3[cd]	− 6.0	− 4.5	− 3.0	− 4.5	10.5	− 8.1	− 6.6	− 5.1	− 6.6
No. 4[c]	−12.8	− 6.0	− 8.3	− 9.0	10.3	−10.3	− 5.9	− 6.6	− 7.4
No. 5[c]	− 3.8	+ 0.8	− 0.8	− 1.1	10.4	− 6.6	+ 0.7	− 1.5	− 2.6
No. 6[d]	− 8.3	− 4.5	+ 5.3	− 2.6	10.5	−10.3	− 6.6	+ 2.9	− 4.8
No. 7[d]	+19.6	+15.8	+13.5	+16.2	10.5	+16.9	+13.2	+11.0	+13.6
No. 8[c]	− 7.5	− 4.5	+ 4.5	− 2.6	10.3	− 6.6	−10.3	−11.0	− 9.2
No. 9[c]	− 4.5	− 5.3	− 6.0	− 5.3	10.3	− 5.1	− 4.4	− 2.9	− 4.0
No. 10	− 3.0	−12.8	− 8.3	− 8.3	10.3	−10.3	−16.9	−10.3	−12.5
No. 11[c]	+ 3.0	+ 1.5	+ 6.0	+ 3.4	10.25	+12.5	+ 1.5	+ 8.8	+ 7.7
No. 12[c]	− 8.3	− 3.8	− 7.5	− 6.4	10.4	− 5.1	− 7.3	− 2.2	− 4.8
No. 13	+ 0.8	+ 4.5	+ 1.5	+ 2.3	10.3	+ 4.4	+ 2.2	− 2.9	+ 1.5
No. 14[c]	− 3.0	− 3.0	− 3.8	− 3.4	10.4	− 2.2	− 4.4	− 2.9	− 3.3
No. 15[cd]	+ 0.8	0.0	0.0	+ 0.4	10.5	− 1.5	− 2.2	− 2.2	− 1.8
No. 16[c]	+ 0.8	+ 2.3	− 3.8	− 0.4	10.4	− 0.7	0	−14.0	− 4.8
No. 17[c]	− 9.8	− 5.3	+ 4.5	− 3.4	10.3	+ 0.7	− 6.6	− 2.9	− 2.9
No. 18	+ 5.3	− 6.0	− 0.8	− 0.8	10.3	+ 5.1	+ 2.2	+ 2.2	+ 3.3
No. 19[b]	− 2.3	+ 2.3	+ 1.5	+ 0.4	10.4	− 8.1	− 9.6	− 2.6	− 6.6
No. 20[c]	+ 8.3	+ 6.0	+ 3.8	+ 6.0	10.3	+11.0	+ 8.1	+ 5.9	+ 8.1
No. 21[cd]	+10.5	+10.5	+ 9.8	+10.5	10.5	+ 8.5	+ 8.1	+ 7.4	+ 8.1
No. 22[c]	+ 2.3	+ 5.3	+ 6.0	+ 4.5	10.4	− 0.7	− 2.2	− 1.5	0
No. 23[a]	+ 9.8	+10.5	+11.3	+10.5	10.3	+22.8	+16.9	+16.2	+19.9
No. 24[c]	− 6.8	− 6.0	−12.0	− 8.3	10.3	−10.3	− 1.5	− 7.4	− 6.2
No. 25[c]	− 0.8	− 1.5	− 7.5	− 3.4	10.3	− 2.2	− 2.9	− 1.5	− 1.8
No. 26[c]	− 4.1	− 4.5	− 7.5	− 5.3	10.4	− 1.5	− 5.1	− 7.4	− 4.8
No. 27[c]	− 2.3	− 3.0	− 2.3	− 2.6	10.4	−11.8	− 2.9	−13.2	− 9.2
No. 28[c]	+ 3.8	+ 2.3	− 4.5	+ 0.8	10.25	+ 7.3	+ 5.9	+ 0.7	+ 4.4
No. 29[cd]	−11.3	−10.5	−12.0	−10.9	10.5	−13.2	−12.5	−14.0	−12.9
No. 30[c]	− 3.8	− 0.8	− 0.8	− 1.5	10.4	− 1.5	+ 0.7	+ 0.7	0
No. 31[c]	+ 3.0	+ 1.5	− 0.8	+ 1.1	10.4	+ 2.9	+ 8.8	+ 0.7	+ 4.0
No. 32[c]	+10.5	+ 9.8	+ 5.3	+ 8.3	10.3	+14.7	+14.0	+10.3	+12.9
No. 33[cd]	+10.5	+ 9.0	+ 7.5	+10.5	10.5	+ 8.1	+ 6.6	+ 5.1	+ 6.6
No. 34[c]	− 6.0	− 8.3	− 9.8	− 8.3	10.3	− 5.9	− 8.8	−10.3	− 8.1
No. 35[c]	0	− 6.0	− 0.8	− 2.3	10.3	+ 0.7	− 2.2	− 2.9	− 1.5
No. 36	− 1.5	+ 2.3	+ 1.5	+ 0.8	10.2	+ 9.6	+ 4.4	+ 2.9	+ 5.5
No. 37[a]	0	+ 8.3	−12.0	− 1.1	10.3	−12.5	+ 0.7	−10.3	− 7.0
No. 38[c]	0	+ 5.3	+ 6.8	+ 4.1	10.3	− 2.9	+ 8.1	+ 8.8	+ 5.1
No. 39[c]	+ 1.5	− 0.8	+ 9.8	+ 3.4	10.4	− 2.2	+ 3.7	+ 3.7	+ 1.8
No. 40[a]	− 0.8	− 2.3	− 1.5	− 1.5	10.3	− 4.4	− 2.2	− 2.2	− 2.9
No. 41	+ 1.5	− 0.8	− 4.5	− 1.1	10.3	− 0.7	+ 0.7	− 6.6	− 2.2
No. 42[c]	+ 3.8	+12.0	− 0.4	+ 5.3	10.3	+12.5	− 0.7	− 6.6	+ 1.8
No. 43[c]	− 5.3	−15.8	−21.8	−14.3	10.4	+ 2.2	−13.2	− 6.6	− 5.5
No. 44[c]	0	+ 5.3	+15.0	+ 6.8	10.3	+ 6.6	+12.1	+14.0	+11.0
No. 45[c]	+ 3.0	+ 9.8	+ 4.5	+ 6.0	10.3	+ 5.9	+ 3.7	+ 7.4	+ 5.5
Average	5.0	5.7	6.1	5.0	10.4	6.7	6.0	6.1	5.8

Percentage Variations in Seven Day Tensile Strength Tests

Laboratory	MORTAR B Percentage of Water Constant 10.5 Per Cent				MORTAR A Percentage of Water Calculated from Vicat Test Made in Respective Laboratory				
	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens	Water, Per Cent	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens
No. 1[c]	0	− 2.8	+ 0.6	− 0.6	10.3	− 0.3	− 0.3	+ 3.0	+ 1.1
No. 2[cd]	+14.5	+11.2	+10.1	+12.0	10.5	+12.3	+ 9.0	+ 7.9	+ 9.8
No. 3[cd]	− 3.9	− 3.9	− 2.8	− 3.6	10.5	− 5.8	− 5.8	− 4.7	− 5.5
No. 4[c]	− 9.5	− 8.4	− 5.0	− 7.5	10.3	− 7.9	− 6.8	− 8.5	− 7.7
No. 5[c]	− 2.2	− 1.1	− 0.6	− 1.4	10.4	− 2.5	− 1.4	− 3.0	− 2.2
No. 6[d]	− 2.8	− 6.7	− 2.8	− 3.9	10.5	− 4.7	− 8.5	− 4.7	− 5.8
No. 7[d]	+ 4.5	+12.8	+19.6	+12.6	10.5	+ 2.5	+10.7	+17.3	+10.4
No. 8[c]	− 2.2	− 6.1	− 6.1	− 4.7	10.3	− 8.5	− 5.8	− 5.2	− 6.3
No. 9[c]	0	0	− 2.2	− 0.6	10.3	+ 6.3	+ 4.7	+ 4.7	+ 5.2
No. 10	− 4.5	− 1.1	− 3.9	− 3.1	10.3	− 1.9	− 2.5	− 4.7	− 3.0
No. 11[c]	+ 1.7	+ 1.1	+ 0.6	+ 1.1	10.2	+ 6.3	− 0.3	+ 0.3	+ 2.2
No. 12[c]	+ 2.2	0	+ 3.4	+ 1.9	10.4	− 5.2	− 4.1	+ 0.3	− 3.0
No. 13	− 6.7	− 2.2	− 1.1	− 3.1	10.3	− 4.1	+ 1.9	− 5.8	− 2.7
No. 14[c]	− 7.3	− 4.5	− 4.5	− 5.3	10.4	− 1.4	− 5.8	− 4.7	− 3.8
No. 15[cd]	+ 1.1	+ 1.1	+ 1.7	+ 1.1	10.5	− 0.8	− 0.8	− 0.3	− 0.8
No. 16[c]	− 5.0	− 0.6	− 7.8	− 4.5	10.4	− 7.4	+ 0.3	− 5.2	− 3.8
No. 17[c]	+ 1.7	+ 4.5	+ 3.4	+ 3.1	10.3	+ 4.1	− 0.8	+ 3.0	+ 2.2
No. 18	− 2.2	− 5.6	− 3.4	− 3.6	10.3	− 1.9	− 2.5	− 2.5	− 2.2
No. 19[b]	− 6.1	− 6.7	− 3.9	− 5.6	10.4	− 6.3	−11.2	− 8.5	− 8.8
No. 20[c]	+ 4.5	+ 4.5	− 1.1	+ 2.5	10.3	+ 5.2	+ 6.3	− 0.3	+ 3.8
No. 21[cd]	+12.8	+ 1.7	+12.8	+ 9.5	10.5	+10.7	− 0.3	+10.7	+ 7.4
No. 22[c]	− 2.8	− 1.1	− 2.2	− 1.9	10.4	− 6.3	− 1.9	− 7.9	− 5.2
No. 25[a]	+ 6.7	+ 7.3	+ 2.2	+ 5.6	10.3	+16.2	+ 9.6	+12.9	+12.9
No. 24[c]	−15.1	−10.6	−12.8	−12.8	10.3	−15.6	−12.3	−11.2	−13.2
No. 25[c]	− 2.2	− 0.6	0	− 0.8	10.3	− 1.4	− 5.2	+ 2.5	− 1.4
No. 26[c]	− 1.7	− 0.6	− 0.6	− 0.6	10.4	− 5.2	− 3.0	− 1.9	− 3.3
No. 27[c]	−10.1	− 8.4	− 7.8	− 8.7	10.4	− 0.8	+ 1.9	− 5.8	− 1.6
No. 28[c]	+ 3.9	+ 1.1	− 3.4	+ 0.8	10.2	+ 1.9	− 1.4	+ 0.3	+ 0.3
No. 29[cd]	−11.7	−11.7	−12.3	−11.7	10.5	−13.4	−13.4	−14.0	−13.4
No. 30[c]	+ 1.1	+ 1.7	+ 3.9	+ 2.5	10.4	+ 1.9	+ 2.5	+ 3.6	+ 2.5
No. 31[c]	+ 3.4	− 1.7	+ 6.1	+ 2.8	10.4	+ 3.0	+ 5.2	− 0.3	+ 2.5
No. 32[c]	+ 8.9	+ 9.5	+ 6.7	+ 8.4	10.3	+10.1	+ 6.8	+ 6.3	+ 7.7
No. 33[cd]	+ 8.9	+ 8.9	+ 7.8	+ 8.7	10.5	+ 6.8	+ 6.8	+ 5.8	+ 6.6
No. 34[c]	− 8.4	− 7.3	− 8.4	− 7.8	10.3	− 8.5	− 6.8	− 8.5	− 7.9
No. 35[c]	− 6.1	− 3.4	+ 2.2	− 2.2	10.3	− 1.4	+ 1.4	− 0.3	− 0.3
No. 36	+ 2.8	+ 3.4	+ 5.0	+ 3.9	10.2	− 5.8	− 5.8	+ 7.4	− 1.1
No. 37[a]	+ 0.6	− 2.8	+ 5.0	+ 1.1	10.3	+ 0.3	− 1.9	+ 5.2	+ 1.4
No. 38[c]	+ 3.9	+ 6.7	+ 3.9	+ 5.0	10.3	+10.7	+ 7.9	+ 6.8	+ 8.8
No. 39[c]	+ 1.1	+ 8.4	+ 9.5	+ 6.4	10.4	+ 3.6	+ 6.3	+ 2.5	+ 4.4
No. 40[a]	− 1.7	− 2.2	− 1.7	− 1.7	10.3	− 4.1	− 1.4	− 0.3	− 1.9
No. 41	+ 2.2	− 2.8	− 3.4	− 1.1	10.3	+ 1.9	+ 0.8	− 0.8	+ 0.5
No. 42[c]	− 5.0	− 5.6	− 6.1	− 5.6	10.3	− 1.9	+ 1.9	+ 3.6	+ 1.1
No. 43[c]	+11.2	+ 3.9	+12.3	+ 9.2	10.4	+ 6.8	+ 1.9	− 2.5	+ 2.2
No. 44[c]	+ 5.0	+ 3.9	+ 7.3	+ 5.3	10.3	+ 7.9	+10.7	− 0.3	+ 6.0
No. 45[c]	0	+11.2	+ 3.9	+ 5.0	10.3	+ 2.5	− 3.0	+ 3.0	+ 1.1
Average	4.9	4.7	5.2	4.7	10.4	5.4	4.7	4.9	4.6

Percentage Variations in Twenty-Eight Day Tensile Strength Tests

Laboratory	MORTAR B Percentage of Water Constant 10.5 Per Cent				MORTAR A Percentage of Water Calculated from Vicat Test Made in Respective Laboratory				
	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens	Water, Per Cent	First Day Average of 3 Specimens	Second Day Average of 3 Specimens	Third Day Average of 3 Specimens	Average of 9 Specimens
No. 1[c]	+ 1.3	+ 2.1	+ 0.4	+ 1.3	10.3	+ 0.4	+ 4.3	+ 3.8	+ 3.0
No. 2[cd]	+ 4.7	+ 2.1	+ 1.7	+ 3.0	10.5	+ 4.3	+ 1.7	+ 1.3	+ 2.6
No. 3[cd]	+ 1.3	+ 2.1	− 1.7	+ 0.6	10.5	+ 0.8	+ 1.7	− 2.1	+ 0.2
No. 4[c]	− 3.9	− 5.6	− 4.3	− 4.5	10.3	− 3.0	− 0.8	− 2.1	− 1.9
No. 5[c]	− 8.2	− 6.0	− 6.4	− 6.9	10.4	− 8.5	− 9.0	− 7.3	− 8.3
No. 6[d]	−18.9	−11.2	−12.9	−14.4	10.5	−19.2	−11.5	−13.2	−14.7
No. 7[d]	+10.3	+12.9	+ 6.4	+ 9.9	10.5	+ 9.8	+12.4	+ 6.0	+ 9.4
No. 8[c]	+ 1.3	+ 6.0	+ 1.7	+ 3.2	10.3	+ 0.4	+ 3.0	+ 0.8	+ 1.3
No. 9[c]	− 6.9	− 6.9	− 5.6	− 6.4	10.3	+ 0.8	+ 0.4	0	+ 0.4
No. 10	−15.4	−14.6	−11.6	−13.7	10.3	−12.0	−12.0	−10.3	−11.5
No. 11[c]	+ 3.0	− 0.9	+ 5.2	+ 2.4	10.2	+ 5.6	0	+ 5.6	+ 3.6
No. 12[c]	− 1.7	0	+ 2.1	+ 0.2	10.4	+ 4.7	0	+ 2.1	+ 2.4
No. 13	− 6.4	− 6.9	− 2.6	− 5.4	10.3	− 4.7	− 6.8	− 7.3	− 6.2
No. 14[c]	−13.3	−17.2	−15.5	−15.2	10.4	− 3.0	− 0.8	− 3.0	− 2.4
No. 15[cd]	+11.2	+ 8.6	+10.7	+10.3	10.5	+10.7	+ 6.8	+10.3	+ 9.8
No. 16[c]	− 2.6	− 7.7	− 2.4	− 4.1	10.4	−11.5	− 3.8	− 7.3	− 7.5
No. 17[c]	− 0.4	+ 6.0	+ 6.0	+ 3.6	10.3	+ 4.3	+ 4.3	+ 5.1	+ 4.5
No. 18	− 6.4	− 3.0	− 6.9	− 5.4	10.3	+ 5.6	− 7.3	− 7.7	− 6.8
No. 19[b]	+ 0.9	− 6.0	− 5.6	− 3.6	10.4	− 8.1	0	+ 1.7	− 2.1
No. 20[c]	+11.6	+12.0	+ 7.3	+10.3	10.3	+11.5	+ 5.1	+10.3	+ 9.0
No. 21[cd]	− 0.4	+ 3.4	+ 3.0	+ 2.1	10.5	− 0.8	+ 3.4	+ 2.6	+ 1.7
No. 22[c]	− 3.4	+ 3.0	+ 5.6	+ 1.7	10.4	− 3.8	− 0.8	+ 5.1	+ 0.2
No. 25[a]	+12.0	+ 9.4	+ 5.6	+ 9.0	10.3	+ 5.1	+ 9.4	+ 6.4	+ 7.0
No. 24[c]	− 4.7	− 4.3	− 9.4	− 6.0	10.3	−12.4	−11.5	− 5.6	− 9.8
No. 25[c]	− 0.9	− 5.6	+ 4.7	− 0.4	10.3	+ 2.1	+ 1.7	− 0.4	+ 1.3
No. 26[c]	− 3.0	− 2.1	− 2.1	− 2.4	10.4	− 5.1	0	− 2.6	− 2.4
No. 27[c]	+ 4.7	− 1.7	− 1.3	+ 0.6	10.4	− 3.8	− 2.1	− 1.7	− 2.6
No. 28[c]	+ 1.3	+ 3.0	+ 3.0	+ 2.4	10.2	+ 4.3	+ 1.3	+ 3.4	+ 3.0
No. 29[cd]	− 5.2	− 6.0	−13.3	− 7.9	10.5	− 5.1	− 6.4	−13.7	− 8.3
No. 30[c]	+ 1.3	+ 1.7	+ 3.0	+ 2.1	10.4	+ 7.3	+ 2.6	+ 8.1	+ 6.0
No. 31[c]	0	+ 1.3	+ 3.0	+ 1.5	10.4	− 3.4	+ 0.8	+ 5.6	+ 0.9
No. 32[c]	+11.6	+12.4	+10.3	+11.4	10.3	+15.4	+ 6.4	+11.5	+13.9
No. 33[cd]	+11.6	+ 8.6	+11.6	+10.7	10.5	+11.1	+ 8.1	+11.1	+10.3
No. 34[c]	− 2.6	− 2.1	− 4.3	− 3.0	10.3	− 0.8	− 1.7	− 2.6	− 1.7
No. 35[c]	+ 1.7	− 0.4	− 3.4	− 0.9	10.3	−10.3	− 6.0	− 5.1	− 7.3
No. 36	− 1.7	− 0.4	− 2.1	− 1.5	10.2	− 3.8	− 1.3	+ 6.0	+ 0.2
No. 37[a]	+ 0.9	+ 3.0	− 0.4	+ 1.3	10.3	− 3.0	− 0.8	+ 4.7	+ 0.4
No. 38[c]	− 2.1	+ 3.9	+ 7.7	+ 3.2	10.3	+ 5.6	+ 4.3	+ 2.1	+ 4.1
No. 39[c]	− 2.6	+ 4.7	− 9.0	− 2.1	10.4	− 0.8	− 0.8	+ 0.8	− 0.2
No. 40[a]	− 5.2	− 5.2	− 3.9	− 4.7	10.3	− 5.1	− 4.3	− 3.4	− 4.3
No. 41	+ 3.4	− 4.7	− 1.7	− 1.1	10.3	+ 3.4	− 0.8	− 1.7	+ 0.4
No. 42[c]	− 2.6	− 8.6	− 3.4	− 4.9	10.3	−10.3	− 0.8	− 4.3	− 5.1
No. 43[c]	+ 9.0	+ 3.4	+ 6.4	+ 6.4	10.4	+16.7	+11.1	+ 6.4	+11.5
No. 44[c]	− 3.4	− 2.6	+11.2	+ 1.5	10.3	− 6.0	− 9.0	+ 4.7	− 3.6
No. 45[c]	+11.2	+13.3	+11.6	+12.0	10.3	− 1.3	+ 3.4	+ 6.4	+ 2.8
Average	5.2	5.6	5.7	5.0	10.4	6.1	4.2	5.2	4.8

[a] These laboratories reported the use of thermostatically controlled moist air storage equipment.
[b] These laboratories reported the use of thermostatically controlled water storage equipment.
[c] These laboratories reported the use of both thermostatically controlled moist air storage equipment and thermostatically controlled water storage equipment.
[d] These laboratories reported the percentage of mixing water determined for Mortar A by the normal consistency test as being the same as that prescribed for Mortar B, data from specimens of one mortar were included in both sections of the above table.

Accelerated Testing of Paints for Iron and Steel[1]

Group 6 of Subcommittee VII on Accelerated Tests for Protective Coatings, of Committee D-1 was formed in 1935 to evaluate the usefulness of accelerated means for testing paint products that are normally applied to iron or steel. It was decided to run a pilot test in an attempt to secure results that would warrant a more extensive series of tests. Three primers and paints were made which would protect steel from rusting and fail within different lengths of time, such as one, three and five years.

The Bell Telephone Laboratories, through one of the cooperators, H. G. Arlt, kindly consented to apply the primers and paints supplied, and by their apparatus regulate the film thickness of each paint within the limits of experimental error. Special steel panels were sandblasted, cleaned with gasoline and sprayed with one coat of each primer. After drying they were sprayed with a second coat of the same primer to which a little carbon black had been added so as to show the color difference between the first and second coats. Three sets of steel panels were sent each cooperator, one set to be exposed 45 deg. south, one set exposed to an accelerated weathering system and the third set retained in the laboratory for future reference. Each cooperator exposed his panels to the accelerated weathering system and to the weather on December 15, 1935.

Results to date from this pilot test reported by the nine cooperators indicate that the accelerated weathering systems revealed panel 2 as being the best by a vote of five to four. Panel 1 is second best, and eight of the nine cooperators determined that panel 3 is third best. This latter panel failed much more quickly than the other two. Seven of the nine cooperators have reported on results secured from 45 deg. southern exposure, and all agree that panel 3 failed first, which checks with our accelerated weathering results. There seems to be a difference of opinion as to the time panels 1 and 2 will fail, and to date some of the cooperators cannot tell the difference. These panels will be exposed further but we believe the results from the pilot test are sufficient to warrant more extensive work.

The conclusions to be drawn, based upon the data available are:

1. The accelerated weathering machines and cycles used reveal comparative differences in life of paints if these differences are wide. They selected the paint designed to fail first.
2. The machines and cycles used in this series of tests did not sufficiently differentiate between two paints which have been exposed for 1½ yr. on test fences located in various parts of the United States. The selection of panel 2 as best by a vote of 5 to 4 is certainly not sufficiently clear cut upon which to base scientific data.

It is interesting to note that the majority of cooperators used the weatherometer for their accelerated testing and that all used over 50 per cent light only, but the amount of water only and light and water varies between 10 and 50 per cent, yet in spite of this difference, the cooperators were able to determine which of these paints was designed to fail first.

One of the primary difficulties in this pilot test was the art of finding the end point; that is, when a panel had rusted sufficiently to warrant its withdrawal from the test, or when rusting of the panel had progressed to a point where the paint could be considered to have failed. This question was discussed at some length at the 1936 annual meeting and it was decided that panels should be selected representing "incipient," "considerable" and "bad" rusting. This was done and each cooperator sent a set of these rusting standards. Practically everyone questioned the selection made. This resulted in all the cooperators attending the meeting of Committee D-1 at Chapel Hill, bringing with them a set of panels which they considered represented various degrees of rusting. It was enlightening to survey the panels presented and to find that there was practically no agreement. Considerable discussion resulted in a decision to adopt only one rusting standard to be based upon the point at which rusting had progressed sufficiently to warrant repainting. Some of the panels brought to the meeting represented such a degree of rust formation. There was no complete agreement concerning the point of rusting requiring repainting.

This difference of opinion is but natural. It occurs when other types of failures are evaluated by a group of men, yet it is a handicap in conducting a series of cooperative tests. It would be a wonderful state if we all had a standard upon which to base our relative degrees of gloss, chalking, checking, etc.

The New York Paint and Varnish Production Club has endeavored to define types of paint failures for the assistance of the committee. We have approached Subcommittee XVIII on Physical Properties of Materials who have been doing some work on this problem. I should like to suggest, that Subcommittee XVIII be given authority to select the various types of paint failures and to designate the relative degree of each type, defining them by word or photograph in such a way that all will understand. It is indeed a broad field of endeavor, and a most appropriate one to be covered in this Society, representing as it does the paint raw material supplier, the paint manufacturer and the paint user, all of whom are vitally concerned in this problem. It is primarly our duty to designate these failure standards and see that they are properly brought to the attention of all interested.

[1]This paper by J. C. Moore, Supt., Paint Plant, Sinclair Refining Co., was one of five presented at the June meeting of Committee D-1 on Paint, Varnish, Lacquer and Related Products.

SOCIETY APPOINTMENTS

Announcement is made of the following Society appointments and representatives:

T. A. Boyd, General Motors Corp.; D. E. Douty, United States Testing Co., Inc.; and R. L. Templin, Aluminum Company of America, on Committee E-1 on Methods of Testing.

J. C. Pearson, Lehigh Portland Cement Co.; C. H. Mathewson, Yale University; and Stanton Walker, National Sand and Gravel Assn., on Committee E-6 on Papers and Publications.

L. B. Tuckerman, National Bureau of Standards; G. B. Waterhouse, Massachusetts Institute of Technology; and R. P. Anderson, American Petroleum Institute, on Committee E-8 on Nomenclature and Definitions.

C. D. Holley, The Sherwin-Williams Co., on Committee E-9 on Research.

J. O. Leech, Carnegie-Illinois Steel Corp., and J. B. Young, Reading Co., on Committee E-10 on Standards.

F. N. Speller, National Tube Co., as the Society's representative on the Committee on Cavitation of the Hydraulic Division, American Society of Mechanical Engineers.

ASTM BULLETIN

Published by

AMERICAN SOCIETY FOR TESTING MATERIALS

No. 89 **December, 1937**

Growing

THE attention of members has been directed in the past two years to the policy of gradually expanding the BULLETIN to make it of still more service to the members. This went into effect in 1935 and was given additional impetus in 1936 and more particularly during the current year.

It is of interest to compare the size of the six BULLETINS for 1935 with those of 1937. Statistics show that the BULLETIN has just doubled in size. A great portion of the increase has come about through the inclusion of papers and reports.

During the present year more than fifteen papers have been published covering such topics as glass, rubber, specifications, statistical methods and their relation to specifications and the like. This issue has important papers dealing with cement, wear of textile materials and an important test for lacquers. The Committee on ASTM BULLETIN is desirous that there not only be a continuing use of papers and reports of direct interest to the members, but that each year will see a definite increase in the number published and to that end will welcome offers of papers from the members. These, of course, must deal with matters within the field of the Society and be of current interest. They may describe a new test method and its application or give a technical description of new piece testing equipment; they may cover research work which has not yet developed to the point of a more formal paper for the *Proceedings*. Obviously one of the important advantages of publishing a paper in the BULLETIN aside from the greater distribution that results is the fact that it reaches the desired audience much sooner than is the case with the annually published *Proceedings*.

Certain proposed test methods have appeared during the year and it is felt that committees will make increasing use of the BULLETIN to stimulate comments on proposed specifications and methods. The attention of committee officers has been directed to the availability of the BULLETIN for accounts of their work and many have responded. One of the important uses of the BULLETIN is to publicize effectively important work under way in various standing committees and their subgroups.

During the coming year plans should result in bigger and better BULLETINS. As a result, it will become of even greater value to the members and those who are in contact with committee work.

Committee Officers at Federal Hearings

DURING the past few months, the chairmen of two of the Society's committees have appeared at Federal hearings—Dr. A. C. Fieldner discussed the work of the Sectional Committee on Classification of Coals at a hearing held by the National Bituminous Coal Commission, and Prof. H. J. Ball, Lowell Textile Institute, chairman of Committee D-13 on Textile Materials presented a discussion of the work of the Society and particularly of Committee D-13, at a Federal Trade Commission hearing on Proposed Trade Practice Rules for Rayon Industry. The hearing at which Doctor Fieldner, chairman of the Sectional Committee on Classification of Coals, appeared, was in accordance with an order of the Commission directing all district boards to propose standards of classification of coals as to kinds, qualities, and sizes.

Doctor Fieldner outlined the extensive work which has been done beginning in 1927 by the Sectional Committee sponsored by the A.S.T.M. under the procedure of the American Standards Association, this work eventually leading to two specifications, one classifying coal according to rank, and the other relating to classification by grade. These systems of classification, he stated, are based on the intrinsic properties of the material, chemical and physical. They are intended to be a scientific approach to the problem.

Professor Ball in his discussion outlining to the Federal Trade Commission the work of the Society, particularly Committee D-13 and the definitions for rayon it has developed, discussed in detail two A.S.T.M. standards – the Tentative Methods of Testing and Tolerances for Rayon (D 258 - 37 T) and the Tentative Methods for the Identification of Fibers in Textiles and for the Quantitative Analysis of Textiles (D 276 - 37 T). After presenting a brief history of the two standards and detailing some of the contents, he said: "I think it is shown that the term 'rayon' alone was not deemed sufficient in the eyes of technical men to give the user an adequate conception of the material he had received. Not only were differences in the types pointed out, but suitable methods of test were provided whereby a rayon of unknown origin could be identified."

Marburg Lecture Committee for 1938

THE committee which will select the Edgar Marburg Lecturer for 1938 has been appointed. Under the rules governing the lecture, this group consists of a member of the Executive Committee, a member of Committee E-9 on Research and a member of Committee E-6 on Papers and Publications. The personnel, representing the respective committees in the order named, is as follows: A. C. Fieldner, *Chairman,* Chief, Technologic Branch, U. S. Bureau of Mines; T. S. Fuller, Metallurgist, Research Laboratory, General Electric Co.; and J. C. Pearson, Director of Research, Lehigh Portland Cement Co.

Subscriptions to Bulletin

As indicated in an earlier BULLETIN, application was made to the Post Office Department for permission to enter the BULLETIN as second class matter for mailing purposes. This application has been granted and in accordance with the Post Office Regulations the BULLETIN has been placed on a subscription basis. All members of the Society (this includes, of course, official representatives of company memberships, etc.) will continue to receive the BULLETIN regularly, a stated portion of the members' annual dues being allotted as the subscription price. The Executive Committee has fixed the subscription price at $1.50 a year in the United States and possessions, $1.75 in Canada and $2 in foreign countries.

A communication has been addressed to several hundred members of Society committees, who are not affiliated with A.S.T.M. through membership, indicating the status of the BULLETIN and soliciting their subscription. With the thought that some members may wish to obtain additional copies for some of their associates or staff members, a subscription order blank is enclosed with this issue.

It will be noted from the article on page 26 that considerable progress has been made during the past year in the gradual expansion of the BULLETIN and that it is intended to amplify the publication in various lines which should make it of still further value to those concerned with the work of the Society.

Symposiums Issued on Consistency and on Accelerated Paint Tests

Because of the interest in two of the extensive symposiums which were features of the 1937 Annual Meeting in New York, namely, the Symposium on Consistency: Critical Discussion on Present-Day Practices in Consistency Measurement and the Symposium on Correlation Between Accelerated Laboratory Tests and Service Tests on Protective and Decorative Coatings, it has been decided to issue the respective papers and discussions as special publications, making them available to members at special prices. Only brief summaries of the two symposiums will appear in the *Proceedings*.

The symposium on accelerated service tests on paints was divided into three sections: finishes for indoor service, paints for exterior service on wood, and paints for iron and steel. Three authorities in the industry were leaders of the respective topics and a large number of other paint chemists, testing engineers and other technologists participated in the discussion. All of this material has been edited and the published symposium will be available shortly. It is estimated that the publication will comprise some 60 pages. Copies can be obtained by members at the special price of 50 cents; the list price is 65 cents per copy.

The annual meeting session in which the Symposium on Consistency was held was extremely well attended, bespeaking the already wide-spread and steadily growing interest in this subject. The symposium was sponsored by Technical Committee II on Consistency, Plasticity and Related Properties, of Committee E-1 on Methods of Testing. This committee has been studying for some years the primary considerations necessary in the establishment of authoritative nomenclature, and the formulation of standard methods of test for determining the rheological properties of matter. Nine technical papers were presented by leading authorities in the field covering such topics as Recent Progress in Consistency Measurement, Definition of Consistency and Theoretical Considerations, and measurements involving such subjects as paint, asphalts, coal tar, petroleum products, rubber compounds, thermosetting resins, and electrical insulating materials.

A review of the progress and new developments in consistency measurement that have taken place since the first Symposium in 1923 are presented in the introduction and in the first paper. The second paper is devoted to a theoretical treatment of the subject and analyzes the various rheological tests established by the Society for complex liquids, plastic solids or plastico-viscous solids. The remaining papers are devoted to considerations of the methods and apparatus and the technique used in testing the rheological properties of a wide variety of materials from the scientific as well as the practical viewpoint, including the significance of such measurements. Experimental data and information showing the typical behavior of various types of testing instruments are given. The papers also include a discussion of the difficulties of correlating the results obtained from different empirical testing devices and the advantages to be derived from the use of fundamental units in measuring the rheological properties of materials.

Rapid progress has been made on the preparation of the publication comprising these papers and copies should be available in the near future. The member's price is 65 cents per copy; the list price is 85 cents. This publication will comprise some 76 pages.

1938 Meeting in Atlantic City

As previously announced the Forty-first Annual Meeting of the Society will be held June 27 to July 1 inclusive at Chalfonte-Haddon Hall in Atlantic City.

On November 3, Committee E-6 on Papers and Publications, which will develop the technical program, held an extended meeting and considered a number of topics which have been suggested. One live topic which may be the subject of a symposium involves impact testing. It will be recalled that a most interesting round-table discussion on this subject was held at the 1937 annual meeting in New York, and many members expressed a feeling at the time that by holding a symposium the Society would be rendering a definite service in clarifying many problems involved in this field of testing. A suggested outline of the proposed symposium was reviewed and a further study is to be made of it.

Other groups of papers to be developed, possibly in the form of symposiums, included such subjects as soundness of concrete. Quite a number of technical papers have been suggested in various fields covering metals, cement and concrete, asphalt, testing and other subjects including water, timber, brick, etc.

Further details of the program of the meeting will be announced from time to time, and the May BULLETIN will of course include the detailed Provisional Program.

The Round Table

Editor's Note.—This article was contributed by H. H. Lester, Senior Physicist, Watertown Arsenal. Doctor Lester has taken a leading part in the institution of these interesting discussions.

The second Round Table Discussion on Physics of Metals took place at Atlantic City on October 18. The American Institute of Mining and Metallurgical Engineers, through its Physics of Metals Committee, did the honors as host. The first meeting, as guest of the A.S.T.M., was held in New York City last June. That meeting was devoted to a discussion of the Round Table idea and how it could be developed for greatest usefulness. The recent one marks the first attempt to present an organized program.

The Round Table developed from ideas in connection with the reorganization of Subcommittee VI on X-ray Methods of A.S.T.M. Committee E-4. Although just starting out in life, the offspring seems possessed of remarkable vigor. It is an intersociety group sponsored by various societies interested in metals, including the American Institute of Physics, but owing allegiance to no one organization.

It has a permanent chairman, Prof. J. T. Norton, of Massachusetts Institute of Technology, and a secretary, Prof. Elmer Hutchisson, of the University of Pittsburgh and Editor of the *Journal of Applied Physics.* Its purpose is as yet not clearly defined, but a dominant idea in its organization was to bring together industrial and academic scientists interested in the basic properties of metals. It was hoped that these two groups, meeting in free discussion, could each, by direct contact, the more readily appreciate the problems, concepts, and points of view of the other. In the end it was hoped that through this association American industry would be benefited by the more ready application to its problems of the methods and results of fundamental research.

The Round Table is an attempt to interpret science for the benefit of industry. This is not a new idea; it is in fact a very old one. The present attempt merely points to one practical method by means of which the desired end may be accomplished.

There were approximately 300 present at the October discussion—metallurgists, mechanical engineers, welding research workers, and physicists. The audience was impressive, for most of them were important men in science and industry. The meeting began at 8 p. m. and ran for about three hours, the last half hour being an informal gathering of groups after the adjournment.

The general subject for discussion was "Elasticity." There was a "technical chairman," Prof. L. W. McKeehan, Director, Sloan Physics Laboratory, Yale University, and three discussion leaders—S. L. Hoyt, A. O. Smith Corp., R. K. Haskell, Watertown Arsenal, and R. L. Wegel, Bell Telephone Laboratories, Inc. Phases of the general subject considered were elastic properties of single crystals, true stress-strain curves for polycrystalline materials, and damping phenomena.

It was intended that the presentations of the discussion leaders would be of secondary importance to the spontaneous contributions from the floor. Under the skillful guidance of the technical chairman, this indeed came close to being true. By way of a parenthetical remark, it should be pointed out that the success of a meeting of this sort is very largely dependent upon the chairman of the meeting. In this case, the selection of chairman was a peculiarly happy one. Professor McKeehan, striking the right note at the beginning, maintained the correct atmosphere and guided the meeting with a skillful touch.

To report the discussion in detail would be difficult and, perhaps, unfair. Although dealing with theory and using largely the language of physics, there was a notable absence of a "high brow" atmosphere. The argument was at times in light vein and some of it irrelevant; must of it was weighty. One of the features of the Round Table is that the discussion is not published—at least without revision by the author—so that it may be spontaneous and unhampered.

No small part of the success of the evening came about because important men attended and participated.

The A.I.M.E., in its capacity as "host" for the Round Table, had arranged a session for Tuesday devoted to technical papers and a lecture in the field of Physics of Metals. These meetings were remarkable because of the enthusiastic reception given to highly mathematical papers.

There is a question as to whether or not this program could have been given without the assistance of the Round Table group, and there is a question as to whether the Round Table would be successful without the support of a program of papers designed to appeal to those who would be expected to attend the Round Table. This can be said—the series of meetings comprising the Round Table, the Physics of Metals session and the science lecture was apparently a satisfactory combination. Possibly this is a good pattern to be followed in future Round Table Discussions.

New Compilation of Cement Standards

There has just been published for the first time a compilation of A.S.T.M. Standards on Cement. This is a special compilation sponsored by the Society's Committee C-1 on Cement and presents in compact, convenient form the various A.S.T.M. standard and tentative specifications and test methods for cement.

The publication also includes the widely used Manual of Cement Testing, and a List of Selected References on Portland Cement (11 pp.), adds much to the value of the publication.

Specifications in the new volume cover portland cement, high-early-strength portland cement, natural cement and masonry cement. The test methods include standardized procedures for sampling, testing and chemical analysis of portland cement, compressive strength of portland-cement mortars and fineness by means of the turbidimeter. Specifications covering sieves for testing purposes complete this compilation.

The various A.S.T.M. standards for cements have been widely used for many years and the new compilation should be of definite convenience to not only those interested from the producing standpoint, but to a great many of the technologists and organizations who are concerned with the use of these materials.

Copies of the publication in heavy paper binding can be obtained at the special members' price of 75 cents. The price to non-members is $1.00.

Committee on Mortars Organized

In the October BULLETIN there was an announcement concerning the reorganization of Committee C-12 on Mortars for Unit Masonry which committee several years ago was temporarily discontinued. At a meeting in Washington on November 4, formal reorganization of the committee was consummated and action was taken on election of officers and committee personnel and the scope of the activities contemplated.

The scope of the committee as approved at the meeting includes the preparation of specifications, test methods, and definitions relating to mortars for use with units of burned clay or shale, sand-lime, concrete and stone and similar materials used in unit masonry, other than those intended for use as refractories.

PERSONNEL

The election of officers resulted in the selection of J. W. McBurney, Senior Technologist, National Bureau of Standards, Washington, D. C., as chairman. Mr. McBurney had been acting as temporary chairman and had arranged the preliminary plans for organizing the work of the new committee. Theodore I. Coe, Technical Secretary, Structural Service Dept., American Institute of Architects, was chosen First Vice-Chairman; H. D. Baylor, Vice-President, Louisville Cement Co., Second Vice-Chairman; and H. C. Plummer, Chief Engineer, Structural Clay Products, Inc., Secretary. These four officers together with Lee S. Trainor, R. E. Roscoe and W. C. Voss comprise the Advisory Subcommittee. The complete personnel of the committee as it exists at the present time is as follows:

PERSONNEL OF COMMITTEE C-12

American Institute of Architects, Theodore I. Coe.
F. O. Anderegg, Owens-Illinois Glass Co.
Brick Manufacturers Association of America, L. J. Reardon
H. S. Brightly, Indiana Limestone Institute
C. C. Connor, New Jersey Bell Telephone Co.
R. B. Crepps, Purdue University
R. E. Davis, University of California
W. C. Hanna, California Portland Cement Co.
Louisville Cement Co., H. D. Baylor
J. W. McBurney, National Bureau of Standards
National Crushed Stone Association, A. T. Goldbeck
National Lime Association, Lee S. Trainor
New York State College of Ceramics, H. G. Schurecht
D. E. Parsons, National Bureau of Standards
J. C. Pearson, Lehigh Portland Cement Co.
H. C. Plummer, Structural Clay Products, Inc.
Portland Cement Association, W. G. Kaiser
Riverton Lime and Stone Co., J. A. McCormick
R. E. Roscoe, Bessemer Limestone and Cement Corp.
Southern Testing Laboratories, Inc., J. F. Carle
U. S. Gypsum Co., H. N. Huntzicker
W. C. Voss, Massachusetts Institute of Technology
Stanton Walker, National Sand and Gravel Association
M. O. Withey, University of Wisconsin

The supplementary regulations governing Committee C-12 limit the membership to 35 voting members.

One of the actions taken at the meeting was to appoint a subcommittee on methods of testing to start immediate work on certain problems. A. T. Goldbeck was appointed chairman of this subcommittee. The various projects to be initiated will be directed by small working groups. It is expected that other subcommittees will be organized as the need arises.

Committee C-12 Officers

J. W. McBurney H. C. Plummer

Actions at Meeting of Cement Committee

The Fall meeting of Committee C-1 on Cement was held on November 5 at the National Bureau of Standards in Washington, D. C. The meeting was well attended by members of the committee and a number of visitors were present.

Several actions affecting standards were approved at the meeting and, subject to favorable letter ballot, will be referred to the Society. Action was taken to recommend the adoption as standard of the two present tentative methods for rapid determination of magnesia, with suitable editorial changes. (Sections 1, 2, 3 and 4 of Tentative Method of Chemical Analysis of Portland Cement, C 114 - 37 T). (In case of dispute the results obtained according to Section 16 of the Methods of Samping and Testing Portland Cement, C 77 - 37 are to govern.) It was decided to retain as tentative the methods for determining manganese and phosphorus (Sections 5, 6, 7 and 8 of C 114 - 37 T). Two proposed tentative methods were reviewed and the committee plans to recommend their publication as tentative by the Society; these cover the determination of potassium and sodium oxides in portland cement and a procedure for determining water soluble alkali in portland cement.

Another important decision reached at the meeting was to recommend the deletion of the fineness requirement from the Standard Specifications for High-Early-Strength Portland Cement (C 74 - 36).

Other subjects of interest were discussed although no action taken by the meeting affected the present standards. A detailed report related the results of the very recent study of the possibilities of pebble mortars—"miniature concrete"—in 2-in. cubes. Three mixes were studied by fourteen laboratories, using three cements.

A large number of laboratories had participated in the comparative tests on which are based the recommendations relating to chemical methods. The results of this work were discussed, and also the program for the investigation of methods for determining free lime in portland cement, which tests are about to be started. A progress report outlined the results of the study now being made of the data accumulated in the recently undertaken investigation of the autoclave test by a group of cooperating laboratories.

A number of other important projects were discussed at considerable length and it is expected that the subcommittees involved will submit reports in advance of the Spring Meeting, at which action may be taken. Questions included a proposed revision of masonry cement specifications (C 91 - 32 T) and the development of specific requirements for slag cements and blended cements. The discussion of fineness resulted in assigning to one of the subcommittees the study of the possibilities of a "bleeding" test for cements.

Committee on Soaps Has Active Meeting

Considerable progress in the development of standard specifications and test methods was made at a series of meetings of Committee D-12 on Soaps and Detergents held in New York City on October 18 and 19. During 1936 and 1937 the committee developed four specifications for various types of soap and soap products, approved methods of sampling and chemical analysis and also definitions of terms. These were published in the 1937 report of the committee and by action at the last Annual Meeting were accepted as A.S.T.M. tentative standards.

At its October meeting in New York, the committee approved recommendations that the Tentative Specifications covering Caustic Soda (D 456 - 37 T), Modified Soda (Sesquicarbonate Type) (D 457 - 37 T), and Soda Ash (D 458 - 37 T) be referred to the Society for adoption as standard. Also the committee decided to recommend that the Proposed Methods of Sampling and Chemical Analysis of Soaps and Soap Products be referred to letter ballot for adoption as standard. These recommendations will be included in the committee's 1938 report.

New standardized test methods for the determination of potash and for the size of soap particles were approved at the meeting and will be proposed for publication as tentative. In its current report the committee published for information extensive Methods of Chemical Analysis of Sulfonated Oils and these, together with proposed specifications for white floating soap, which were discussed, are to be submitted to the Society as proposed new standards.

Existing tentative definitions covering commercial soap and soap powder are to be revised—these were referred back to the subcommittee for further study. A number of new tentative definitions of terms were reviewed at the meeting and were approved.

In considering its program of work for the future, the committee decided to concentrate on the preparation of specifications for industrial soaps, soap powder and built soaps and also the development of standard methods for determining carbon dioxide and iodine value of fats.

The meetings in New York were directed by H. P. Trevithick, Chief Chemist, New York Produce Exchange, and B. S. Van Zile, Chemist, Colgate-Palmolive-Peet Co., chairman and secretary, respectively.

Joint Chicago Meeting on Fuels

The Chicago Section of the American Institute of Mining and Metallurgical Engineers and the A.S.T.M. members in the Chicago district will hold a joint meeting on Wednesday, December 8, at the Chicago Engineers' Club. Dr. A. C. Fieldner, past-president of the A.S.T.M., and Chief, Technologic Branch, U. S. Bureau of Mines, will give an address on the subject, "Fuels of Today and Tomorrow." All of the members of the Society, and others who are interested in the subject, are cordially invited to attend this meeting. Dinner will be served at 6:30 p.m., with the meeting proper starting at 7:30 o'clock.

Eastern Mines Experiment Station Dedicated

The new Eastern Experiment Station of the U. S. Bureau of Mines was dedicated at College Park, Md., on October 15, in cooperation with the University of Maryland. Following a joint meeting in the morning of divisions of the American Institute of Mining and Metallurgical Engineers, there was a luncheon, and formal dedication ceremonies took place at 3 p. m. with addresses by Dr. John W. Finch, Director, U. S. Bureau of Mines; Dr. H. C. Byrd, President, University of Maryland; and Hon. Harry W. Nice, Governor, State of Maryland. The inspection of the new building and laboratories followed. During luncheon, representatives of various bodies and special guests were introduced. Secretary-Treasurer Warwick officially represented the Society.

In the program it was pointed out that "With the growth of the Bureau of Mines, it was found necessary to bring the administrative heads of the technical divisions to the Washington Office. This brought about the need for facilities to carry on certain experimental work under the direct supervision of the division chief, a need that could best be met by an experiment station, having proper laboratory equipment, in the immediate vicinity of Washington. A careful survey showed that since the required facilities were not available in any existing buildings in the district, it would be necessary to construct a new building for the purpose."

The new station of the colonial type of architecture which conforms with adjacent structures on the University of Maryland campus consists of a main building, approximately 53 by 114 ft. and two wings each 50 by 113 ft. The operation and maintenance of the building and grounds, and various services of the station are under the direction of the Superintendent of the Station who reports to the Chief of the Technologic Branch, Dr. A. C. Fieldner, past-president of the Society.

The Technologic Branch has charge of the technical investigations which are carried on chiefly in the experiment stations. There are six divisions of the research work: Mining, Metallurgical, Petroleum and Natural Gas, Coal, Explosives, and Nonmetals. The Mining Division deals chiefly with mining methods and research in connection with mine operation. The Metallurgical Division investigates recovery of metals from their ores and devises new or improved methods in order to render available ores not now worked and to permit more complete recovery from those that are now worked. The Petroleum Division handles problems associated with the output and utilization of petroleum to prevent unnecessary wastes both in production and use. The Coal Division studies solid fuels, with respect to conservation and more efficient utilization. The Explosives Division tests explosives with respect to their safety for use underground and other phases of combustion which lead to the increased safety of workers. The Nonmetals Division is interested in methods of production and utilization of nonmetallic minerals to prevent unnecessary waste.

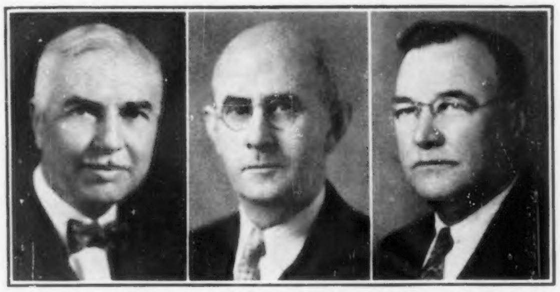
In connection with the opening of this new station it is of interest to note that on October 19 the new buildings at the experiment station at Bartlesville, Okla., were formally dedicated.

XVI. Long-Time Society Committee Members

Sixteenth in the Series of Notes on Long-Time Members

There are presented below as a continuation of the series of articles in the ASTM BULLETIN comprising notes on the outstanding activities of long-time A.S.T.M. members, outlines of the work of three additional members. In general the men whose activities are described in this series have been affiliated with the Society for 25 years or more and have taken part in committee work for long periods of time. No definite sequence is being followed in these articles.

H. H. SCOFIELD, Professor of Materials, School of Civil Engineering, Cornell University, Ithaca, N. Y., after graduating from the Fredonia, N. Y., State Normal School, entered Cornell and received his M.E. degree in 1905. He was on the faculty of Purdue University, 1905 to 1918; Assistant Inspection Engineer, Curtiss Aeroplane Co., 1918 to 1919; and from 1919 has been professor at Cornell. His extra-curricular activities have included direction of the sampling and testing of rail steel in the investigation of rail steel reinforcement bars, 1911 to 1912; and testing engineer on the construction of three reinforced concrete buildings, 1929 to 1930.



A. H. White H. H. Scofield Allen Rogers

Professor Scofield has been a member of the Society since 1908. His active committee affiliations include Committee A-1 on Steel, member since 1916, in which he is a member of the subcommittee on reinforcing steel. He has been on Committee D-4 on Road and Paving Materials since 1914, and is a member of Committee C-5 on Fire Tests of Materials and Construction.

He has presented a large number of technical papers at meetings and numerous articles from his pen have appeared in technical journals. He collaborated with Prof. W. K. Hatt in writing the "Laboratory Manual of Testing Materials." His most recent paper concerned "Some Tests to Show the Effect of Freezing on the Permeability, Strength, and Elasticity of Concretes and Mortars" was presented at the Fortieth A.S.T.M. Annual Meeting in New York City. Professor Scofield is a member of the American Concrete Institute, American Association for the Advancement of Science, National Research Council, and the Society for the Promotion of Engineering Education.

A. H. WHITE, Professor of Chemical Engineering, and Head, Department of Chemical and Metallurgical Engineering, University of Michigan, Ann Arbor, Mich., was graduated from the University of Michigan with the degree of A.B. in 1893; he continued his studies at the Federal Polytechnicum, Zurich, Switzerland. In 1904 he received his B.S. degree in Ch. E. from Michigan. He was Assistant in Chemistry at the University of Illinois, 1893 to 1896, and since 1897 has been a member of the faculty of the University of Michigan. He has been Professor of Chemical Engineering since 1907 and head of the department since 1914. From 1917 to 1919 he was Captain in the Ordnance Dept., and later Lt. Col. and Associate Chief of the Nitrate Division.

A member of the Society since 1909, Doctor White has been continuously a member of Committee D-5 on Coal and Coke and has acted as chairman of various subcommittees from time to time. He is also a member of Committee D-19 on Water for Industrial Uses. As chairman of the Subcommittee on Standardization of Water Analysis Methods, he is in charge of important research work for the Joint Research Committee on Boiler Feedwater Studies.

He is the author of a book on "Technical Gas and Fuel Analysis" and has presented some 60 research papers in various technical journals, a number of these papers appearing in the *Proceedings* beginning with 1909, dealing with various problems involving cement.

Professor White has been granted some ten United States patents on subjects connected with gas manufacture, water purification and utilization of waste liquors from pulp mills and the like. He is former president of the American Institute of Chemical Engineers and the Michigan Gas Association, and holds membership in several societies including the American Chemical Society, Army Ordnance Association, and the American Gas Association.

ALLEN ROGERS, Supervisor, Course in Industrial Chemical Engineering, Pratt Institute, Brooklyn, N. Y., received his degree of B.S. in Chemistry from the University of Maine in 1897; M.S. degree in 1900 and Ph.D. from the University of Pennsylvania in 1902. He was Senior Fellow and Instructor in Organic Chemistry, University of Pennsylvania, until 1904; Research Chemist, Oakes Manufacturing Co., for a year, and from 1905 to 1920 was in charge of Industrial Chemistry at Pratt Institute. He has been in his present position since 1920. During the World War he was a Major in the Chemical Warfare Service in charge of Industrial Relations. He has been awarded numerous patents in connection with leather, furs, inks, oils and paints.

Doctor Rogers has been affiliated with the Society since 1910 and this is also the date of his membership on Committee D-1 on Paint, Varnish, Lacquer and Related Products. He has been very active in the work of various subcommittees and in 1920 was elected chairman of the main committee which office he has held since that time.

Doctor Rogers is the author of several textbooks—Manual of Industrial Chemistry (5 editions), Elements of Industrial Chemistry (2 editions), Laboratory Guide of Industrial Chemistry (2 editions) and on Practical Tanning. The societies in which he holds membership include the following: American Chemical Society, Society of Chemical Industry, American Institute of Chemical Engineers, American Institute of Chemists, American Leather Chemists Association and the Technical Association for the Fur Industry. In 1920 he was awarded the Grasselli Medal of the Society of Chemical Industry for his work on shark leather. This medal is awarded for the paper presented within the past five years which offers the most useful suggestions in applied chemistry.

Symposium on Corrosion Testing

THE seven technical papers comprising the Symposium on Corrosion Testing Procedures have been issued in the form of a special publication of 131 pages. This symposium was held at the March Regional Meeting of the Society in Chicago and although there was extensive discussion of the papers at the time, the committee in charge felt the subject of such importance that it warranted additional time for further discussion. This was effected through a special session at the annual meeting in New York City.

Twelve outstanding authorities prepared the technical papers and many others contributed to the discussion—one-fourth of the volume is devoted to discussion, thus making available in concise form the opinions of other technologists and engineers who have done important work in this field. The symposium covers principles of corrosion testing, atmospheric testing, salt-spray testing, methods for copper alloys, soil corrosion, liquid corrosion and electrical resistance method of determining corrosion rates.

Copies of the publication can be obtained by members at the special prices of 75 cents in paper cover and $1 in cloth. The prices to non-members are $1.25 and $1.50, respectively.

New Book on Electrical Measurements

THERE has recently been published by the McGraw-Hill Book Co., Inc., New York City, a new volume on "Electrical Measurements—Precise Comparisons of Standards and Absolute Determinations of the Units." The author is Dr. H. L. Curtis, Principal Physicist, National Bureau of Standards.

The increasing demand for precision in electrical measurements has emphasized the need for a text that places special emphasis on accuracy of measurement. This is especially the case in regard to those absolute electrical measurements which are used to establish the values of the electrical units. This book has been prepared to make available the technique that has been developed in this field.

The book gives comprehensive descriptions of the important methods used in absolute measurements of the electrical units. Only those methods which will give very accurate results are included. In the descriptions of most of the methods, there is a discussion of every feature that will introduce an error of one part in a million in the final result. A unique feature is the treatments of the strong and weak points of the different methods.

Some of the major topics covered in specific chapters in the publication concern definitions and principles, history, standards, international units, construction of resistance standards, standard cells and methods of comparing standards and the like. Complete chapters are devoted to absolute measurement of various units, such as resistance, current, electromotive force and the like. The book is well printed with serviceable heavy paper cover, 305 pages. Copies can be obtained from the publisher at $4 each.

EDITOR'S NOTE.—There are constantly being written by members of the Society various publications and books dealing with subjects of interest to many of the Society members. Review copies of such books will be welcomed for notice in the BULLETIN. The volume reviewed above is an example of an interesting new publication by one of the Society's very active members.

Factors in the Selection of Coal

THERE has been issued by the National Committee on Coal of the National Association of Purchasing Agents a report on "Technical Factors Recommended for Consideration in the Selection of Coal and Their Relative Importance." This report, prepared by the Subcommittee on Correlation of Scientific Classification with Use Classification,[1] summarizes the results of a questionnaire sent to prominent fuel technologists and is published for information only. The report covers the four objectives embodied in the original assignment given to the subcommittee involving the correlation of use classifications of coal with the scientific classifications and information on various other coal selection factors which have been developed in technical committee work during recent years.

It was considered impracticable to collect and evaluate all available information on the range of chemical and physical properties desired in coal for each specific use. Simpler objectives were therefore set up, as follows:

1. The preparation of a tabulation of the various chemical and physical factors which affect the selection of coal for various uses, together with a reference to where a standard or published method can be found for determining each factor in the laboratory.
2. The preparation of a second tabulation showing the various industrial and domestic uses of coal, subdivided according to distinct types of equipment and conditions of use which affect coal selection.
3. The combination of the above two tabulations into a series of blank charts. These charts formed a questionnaire which was sent to a selected group of fuel technologists with the request that they indicate the relative importance of each coal selection factor for all the uses of coal for which they had special technical knowledge.
4. The compilation and averaging of the results obtained by the questionnaire method, and their publication as general information, in order to show what technical factors should be given consideration when selecting coal for specific uses and conditions.

The report as published by the National Association of Purchasing Agents represents the completion of the above objectives. While the charts do not contain specifications or recommendations as to what kind of coals should be selected for any use, they should be a helpful guide both to the consumer who wishes to know what coal characteristics should be considered in order to make the proper selection of coal for his particular needs, and to the coal producer who wishes to reach those markets for which his products are best suited. The ratings on the charts represent in each instance the average present opinion of a number of fuel technologists.

Copies of this published report can be obtained from the National Association of Purchasing Agents, 11 Park Place, New York City. T. W. Harris, Jr., E. I. du Pont de Nemours & Co., Inc., is chairman of the N.A.P.A. National Committee on Coal and he serves as chairman of Subcommittee VI. He also is vice-chairman of the Technical Committee on Coal Classification.

[1] This is Subcommittee VI of the Technical Committee on Coal Classification, one of the working committees of the Sectional Committee on Classification of Coals.

Address Wanted

Anyone knowing the present address of the following member, whose last-known address is given below, is asked to notify the Secretary-Treasurer:

Herbert Ottley Jeffries, Jr., Research Assistant, The Barber Co., Inc., Technical Bureau, Maurer, N. J.

PERSONALS . . . News items concerning the activities of our members will be welcomed for inclusion in this column.

At the Eighteenth Annual Meeting of the American Petroleum Institute, held in Chicago, November 8 to 12, K. G. MacKenzie, Consulting Chemist, The Texas Company, was presiding officer at the first group session of the Division of Refining. J. B. Rather, In Charge, General Laboratories, Socony-Vacuum Oil Co., Inc., presided at the second group session and T. G. Delbridge, Manager, Research and Development Dept., The Atlantic Refining Co., presided over the closing group session.

On July 1 of this year, W. K. Hatt, Head of the Civil Engineering School and Director of the Materials Testing Laboratory at Purdue University, was relieved of his administrative duties for the purpose of organizing the Joint Highway Research Project between the Indiana State Highway Commission and Purdue University for which the legislature has appropriated $50,000 a year. Professor Hatt's duties at the University would be complete in June, 1939, after forty-four years of service.

John Howe Hall, formerly Technical Assistant to President, Taylor-Wharton Iron and Steel Co., High Bridge, N. J., has resigned his connection with this company and is now Consulting Engineer, Germantown, Philadelphia, Pa.

W. E. Rosengarten, Township Engineer, Lower Merion Township, Ardmore, Pa., was elected a director of the American Public Works Association at its recent convention.

J. T. MacKenzie, Chief Chemist, American Cast Iron Pipe Co., Birmingham, Ala., will present the 1938 official exchange paper of the American Foundrymen's Association before the Institute of British Foundrymen.

George M. Rapp, formerly Assistant Engineer, Port of New York Authority, New York City, is now connected with the Pittsburgh Corning Corp., Pittsburgh, Pa., as Chief Engineer.

D. E. Ackerman has been appointed Associate Professor of Metallurgy, Purdue University, Lafayette, Ind. Formerly he was Metallurgist, Research Laboratory, The International Nickel Co., Inc.

A. F. Riehle, who was connected with Riehle Testing Machine Division, American Machine & Metals, Inc., New York City, as General Manager, is now Manager, Welder and Rod Sales Division, Harnischfeger Corp., Milwaukee, Wis.

Orlando Kromer is now connected with the Minneapolis Moline Power Improvement Co., Minneapolis, Minn., as Engine Designer.

H. A. Mereness is now Director of Research, the National Federation of Textiles, Inc., New York City. He was formerly Economist, U. S. Department of Labor, Washington, D. C.

G. E. F. Lundell, formerly Assistant Chief, is now Chief, Chemistry Division, National Bureau of Standards, Washington, D. C.

C. F. Biggert has retired from active service as Vice-President of Wisconsin Steel Co. after 47 years of service.

J. T. York, who was Assistant at Purdue University, West Lafayette, Ind., is now Apprentice, Bethlehem Steel Co., Fabricated Steel Division, Pittsburgh, Pa.

The Power Piping Society, a member of A.S.T.M., at its meeting in September changed its name to Pipe Fabrication Institute.

F. M. Becket, Vice-President, Electro Metallurgical Co., New York City, was awarded the Edward Goodrich Acheson Medal and a $1000 prize by the Electrochemical Society at a reception in his honor on October 15 in St. Louis. Doctor Becket was chosen as the recipient of the Medal for his contribution in the field of electrothermics, in particular his work on silicon and ferro-alloys made in the electric furnace.

P. D. Merica, Vice-President and Director, The International Nickel Co., Inc., has been chosen for award of the 1938 John Fritz Gold Medal for "important contributions to the development of alloys for industrial uses." This award, highest of American engineering honors, is made annually by a board representing the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

H. L. Howe, Engineer, Department of Public Works, Division of Engineering, City of Rochester, and past-president of the Rochester Engineering Society, has been elected to the Board of Directors of the American Public Works Association.

A. R. Lange, formerly Technical Director, Swan-Finch Oil Corp., New York City, is now General Manager, Sulflo Corp. of America, Elizabeth, N. J.

P. W. Rolleston is now connected with the Aluminum Laboratories, Ltd., Montreal, Canada, as Engineer. He was formerly Sales and Development Engineer, Northern Aluminum Co., Ltd., London, England.

A. C. Fieldner, Chief, Technologic Branch, U. S. Bureau of Mines, Washington, D. C., will give an address on "Fuels of Today and Tomorrow" at meetings of the Ohio Valley, Chicago, Cleveland and Boston Sections of the American Institute of Mining and Metallurgical Engineers on November 20, December 8, December 10, 1937, and January 10 (or 11), 1938.

C. M. Larson, who was Supervising Engineer, Sinclair Refining Co., New York City, is now Chief Consulting Engineer with the same company.

R. O. Griffis is connected with Richard Thomas and Co., Ltd., London, England. He was Research Engineer, Bethlehem Steel Co., Inc.

W. H. C. Webster, formerly Metallurgist, New York Shipbuilding Corp., Camden, N. J., is now Metallurgical Observer (Open Hearth), Carnegie-Illinois Steel Corp., Youngstown, Ohio.

L. E. Lumpkin is now Southern Service Manager, Marquette Cement Mfg. Co., Memphis, Tenn. He was Engineer of Materials and Tests, Arkansas State Highway Dept.

B. B. Betty, who was Special Research Assistant, Engineering Experiment Station, University of Illinois, is now Research Engineer, The International Nickel Co., Inc., Huntington, W. Va.

C. T. Raber, formerly Senior Chemist, Pennsylvania State Highway Dept., is now Chemical Engineer, Glens Falls Portland Cement Co., Glens Falls, N. Y.

Yuinpeng Mars is now Assistant Chief Engineer, Liangcheh Saltworks Reorganisation Commission, Hangchow, Chekiang, China. He was Assistant Engineer and Manager, Shantung Depot Construction Committee, Engineering Dept., Tsingtao, China.

S. F. Cox, who was Research Engineer, Diamond Power Specialty Corp., Detroit, Mich., is now Director of Development Dept., Pittsburgh Plate Glass Co., Pittsburgh, Pa.

O. E. Hovey, Consulting Engineer, New York City, and J. R. Worcester, Civil Engineer, Boston, Mass., have been elected to Honorary Membership in the American Society of Civil Engineers. Mr. Hovey was also made Director of Engineering Foundation.

At the recent meeting of the American Society of Metals, held in Atlantic City, the following A.S.T.M. members were elected as officers for the coming year: G. B. Waterhouse, Professor of Metallurgy, Massachusetts Institute of Technology, President; Bradley Stoughton, Director of Metallurgical Engineering and Dean, College of Engineering, Lehigh University, Treasurer; H. A. Anderson, Metallurgical Engineer, Western Electric Co., Inc., and J. P. Gill, Chief Metallurgist, Vanadium Alloys Steel Co., as Trustees. The following Trustees continue in office: R. L. Kenyon, Research Metallurgist, American Rolling Mill Co., and O. W. Ellis, Director, Department of Engineering and Metallurgy, Ontario Research Foundation.

O. F. Allen, Consulting Engineer, New York City, has severed his connection with the Public Works Administration in New York to devote more time to his consulting engineering practice, especially in reference to diesel engines, power plants and international engineering and production liaison. He continues as Managing Director of Martin Motors, Inc., and Secretary and Director of American Rezo, Inc.

Congress for Applied Mechanics

A circular has been prepared by those in charge of the arrangements for the Fifth International Congress for Applied Mechanics to be held at Harvard University and Massachusetts Institute of Technology in September, 1938. Those who are interested in obtaining further details of the Congress can obtain a copy of the circular by addressing a communication to the congress, Massachusetts Institute of Technology, Cambridge, Mass. All those who expect to attend the congress are asked to transmit their addresses in order that they may be sent further notices.

NEW MEMBERS TO NOVEMBER 12, 1937

The following 8 members were elected from October 13 to November 12, 1937:

Individual Members (8)

Bowman, R. G., Engineer, Seversky Aircraft Corp., Farmingdale, Long Island, N. Y.

Ebright, H. L., Manager, Robert W. Hunt Co., 813 Arctic Building, Seattle, Wash.

Edlund, K. R., Research Director, Shell Petroleum Corp., Wood River, Ill.

Hardy, J. G., Proprietor, James G. Hardy and Co., 354 Fourth Ave., New York City.

Schmidt, E. F. E., Vice-President—Operating Manager, Lone Star Gas Co., 1915 Wood St., Dallas, Tex.

Sweet, W. W., Chemical Engineer, Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J.

Walker, J. H., Engineer Assistant to the General Manager, The Detroit Edison Co., 2000 Second Ave., Detroit, Mich.

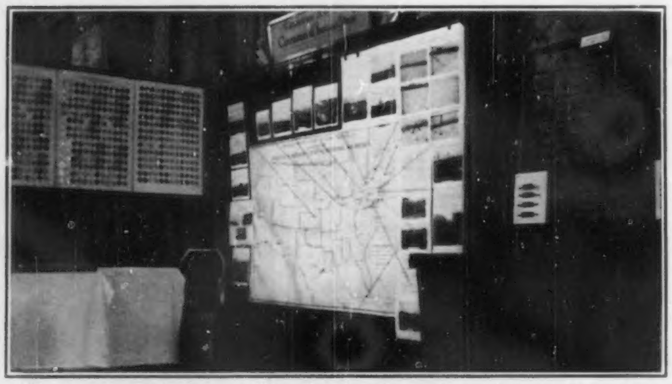
Zapata, Joseph, Senior Chemist in Charge of Bituminous and Chemical Laboratory, Wisconsin State Highway Commission, Madison, Wis. For mail: 413 Engineering Building, University of Wisconsin, Madison, Wis.

1937 Book of A.S.T.M. Tentative Standards

The 1937 edition of the Book of A.S.T.M. Tentative Standards was completed early in November and all those who have ordered copies should by this time have received them. This volume gives in their latest approved form all of the A.S.T.M. tentative specifications, test methods, etc., with the exception of the methods of chemical analyses of metals which are issued in a special compilation. In the latest edition of this widely used book there are 293 tentative specifications. Of these 52 relate to ferrous metals; 36 to non-ferrous metals; 37 apply to cementitious, ceramic, concrete and masonry materials; 158 cover miscellaneous materials such as paints, petroleum, electrical insulation, textiles, etc.; while 10 are general testing methods applying to these materials.

It is interesting to note in connection with this volume that it is the largest publication yet issued by the Society, containing 1629 numbered pages. The record for size was held previously by the 1935 Book of Tentative Standards.

The publication is of special significance and value because it provides a compilation of the large number of new tentative standards first approved and published this year, in addition to those which have been continued from previous years. This book is available to members at the special price of $4.50, heavy paper cover; $5.50 in cloth binding. The prices to non-members are $7 and $8 respectively.



Display at 1937 Annual Meeting by Committee A-5 on Corrosion of Iron and Steel

Calendar of Society Meetings

(Arranged in Chronological Order)

American Society of Mechanical Engineers—Annual Meeting, December 6-10, New York City; Spring Meeting, March 23-25, Los Angeles, Calif.; Semi-Annual Meeting, June 20-24, St. Louis, Mo.

American Association for the Advancement of Science—December 27 - January 1, Indianapolis, Ind.

Society of Automotive Engineers—Annual Meeting, January 10-14, 1938, Detroit, Mich.

American Society of Civil Engineers—Annual Meeting, January 19-21, 1938, New York City; Spring Meeting, April 20-22, Jacksonville, Fla.

American Institute of Electrical Engineers—Winter Convention, January 24-28, New York City; Summer Convention, June 20-24, Washington, D. C.

American Society of Heating and Ventilating Engineers—January 24-28, Grand Central Palace, New York City.

American Society of Refrigerating Engineers—January 26-28, New York City.

American Institute of Mining and Metallurgical Engineers—Annual Meeting, February 13-17, New York City.

American Concrete Institute—February 22-24, Chicago, Ill.

Technical Association of the Pulp and Paper Industry—Annual Meeting, February, New York City.

American Railway Engineering Association—March 15-17, Chicago, Ill.

American Ceramic Society—Fortieth Annual Meeting, March 27-April 2, New Orleans, La.

American Chemical Society—Semi-Annual Meeting, April 18-21, Dallas, Texas.

American Water Works Association—Annual Convention, April 24-28, New Orleans, La.

American Foundrymen's Association—May 14-19, Cleveland, Ohio.

Folders and Literature Received

Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York City. Supplementary Catalog No. 40. This 64-page catalog is a supplement to their large complete Catalog No. 40 and describes in detail the precise electrical measuring instruments manufactured. The catalog covers a large number of grades and types of apparatus and instruments including microammeters, milliammeters, ammeters, galvanometers, millivoltmeters, voltmeters, ohmmeters, wattmeters and Braestrup irradiometer.

Tinius Olsen Testing Machine Co., 500 N. Twelfth St., Philadelphia, Pa. Bulletin No. 11 covers the Olsen stiffness testers for a wide range of metallic and non-metallic materials. Illustrations and details of the testers are given for various ranges from ½ to 40-in. lb. moment capacity. There is a section on method of testing illustrated with numerous stress-strain diagrams and descriptions of the preparation of sheet metal specimens. 12 pages.

H-B Instrument Co., Inc., 2518 N. Broad St., Philadelphia, Pa. Blue Book—Part 4. Describes sensitive temperature controls for science and industry, including the new regulator units. Thermostats, angle thermometers and thermal regulators for use in the radio broadcasting field are described. Also, electrically operated solenoid valves. 10 pages.

Alfred J. Amsler & Co., Schaffhouse, Switzerland. American and Canadian representative: Herman A. Holz, 167 E. Thirty-third St., New York City. A folder describing Amsler torsion dynamometers which are suitable for measuring the power absorbed by fast running machines (pumps, ventilators, generators, etc.), and for measuring the power developed by fast running motors (turbines, electric motors, combustion engines, etc.). The folder describes their working principle and their advantages. 4 pages.

The Polarizing Instrument Co., 8 W. Fortieth St., New York City. Polaroid and Polarized Light—a 16-page booklet covering history and discussion of polarized light, natural sources and dichroic crystals. Polaroid is covered, its transmission characteristics and there is a brief resume of its principal applications which include the polarizing microscope. Sent to A.S.T.M. members on request.

General Radio Co., Cambridge, Mass. Catalog J—covering the many types of instruments and apparatus manufactured, including industrial devices such as stroboscopes, color comparator, sound level meter and the variac. Separate sections of the catalog are devoted to numerous other instruments including resistors, condensers, inductors, frequency—and time-measuring devices, oscillators, amplifiers, bridges and accessories; also standard-signal generators, oscillographs, cameras, and analyzers; meters, and power supplies. A section is devoted to parts and accessories, one on appendix and data tables and there are indexes by type number and also by title. 171 pages.

ing,
Los

nber

-14,

19-
ville,

tion,
-24,

uary

New

An-

nual

ago,

April

-21,

-28,

o.

York
s a
in
The
and
gal-
and

del-
vide
tails
lb.
ted
ara-

Pa.
ence
ngle
ting
10

and
St.,
ters
ning
the
ors,
rin-

ork
his-
roic
here
the

any
trial
the
ther
and
ries;
ers;
ries,
nber